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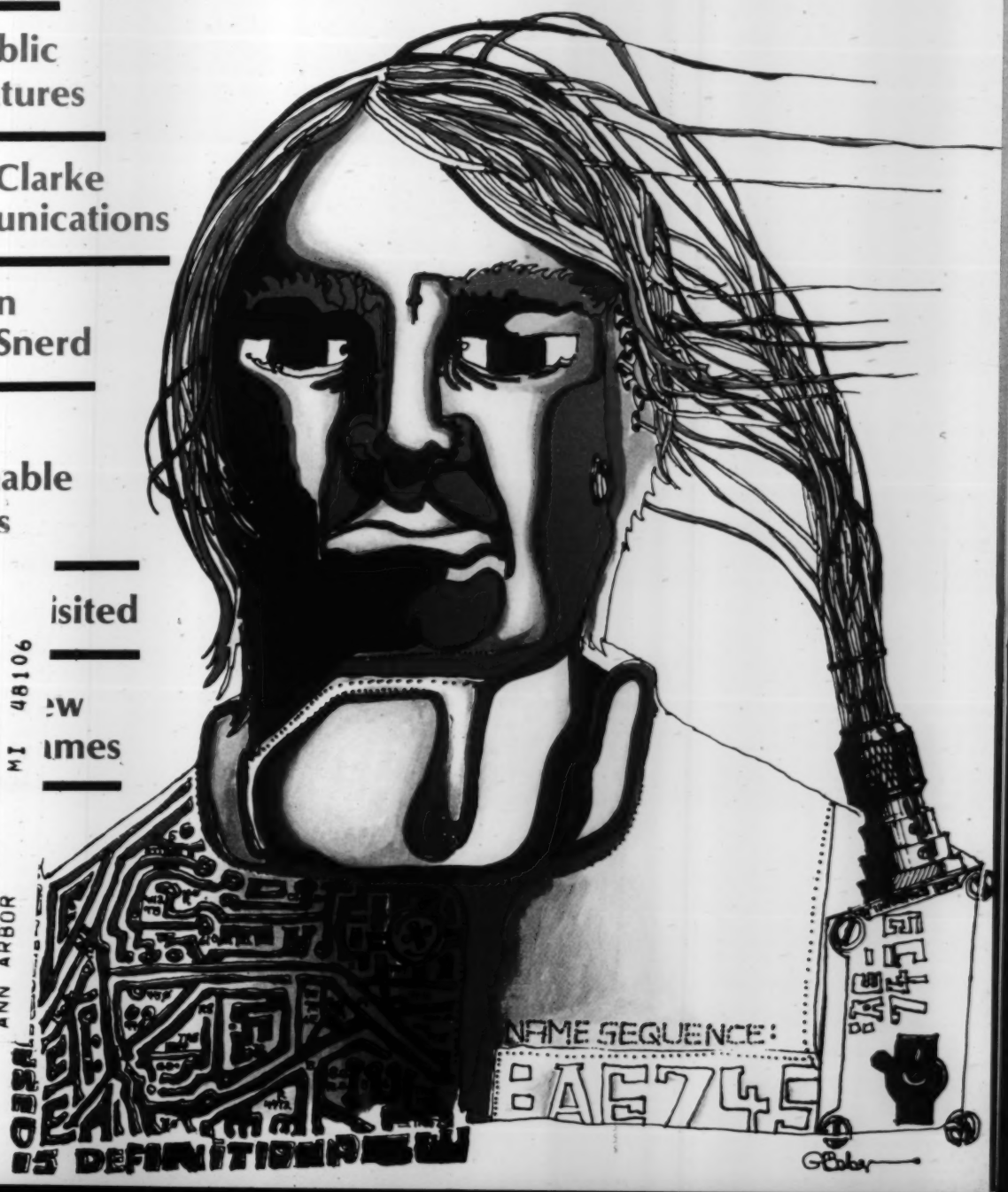

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Meet the most powerful μC system available for dedicated work. Yet it's only $595.*

Here's the muscle you've been telling us you wanted: a powerful Cromemco microcomputer in a style and price range ideal for your dedicated computer jobs—ideal for industrial, business, instrumentation and similar applications.

It's the new Cromemco Z-2 Computer System. Here's some of what you get in the Z-2 for only $595:

- The industry's fastest μP board (Cromemco's highly regarded 4 MHz, 250-nanosecond cycle time board).
- The power and convenience of the well-known Z-80 μP.
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- A full-length *shielded* motherboard with 21 card slots.
- Power-on-jump circuitry to begin automatic program execution when power is turned on.
- S-100 bus.
- Standard rack-mount style construction.
- All-metal chassis and dust case.
- 110- or 220-volt operation.

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The new Z-2 is specifically designed as a powerful but economical dedicated computer for systems work. Notice that the front panel is entirely free of controls or switches of any kind. That makes the Z-2 virtually tamper-proof. No accidental program changes or surprise memory erasures.

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Since the Z-2 uses the Z-80, your present 8080 software can be used with the Z-2. Also, Cromemco offers broad software support including a monitor, assembler, and a BASIC interpreter.

The Z-2 uses the S-100 bus which is supported by the peripherals of dozens of manufacturers. Naturally, all Cromemco peripherals such as our 7-channel A/D and D/A converter, our well-known BYTESAVER with its built-in PROM programmer, our color graphics interface, etc., will also plug into the S-100 bus.

LOW, LOW PRICE

You'll be impressed with the Z-2's low price, technical excellence and quality. So see it right away at your computer store—or order directly from the factory.

Z-2 COMPUTER SYSTEM KIT (MODEL Z-2K) (includes 4 MHz μP card, full-length 21-card-slot motherboard, power supply, one card socket and card-guide set, and front panel; for rack mounting) . . . . . $595.

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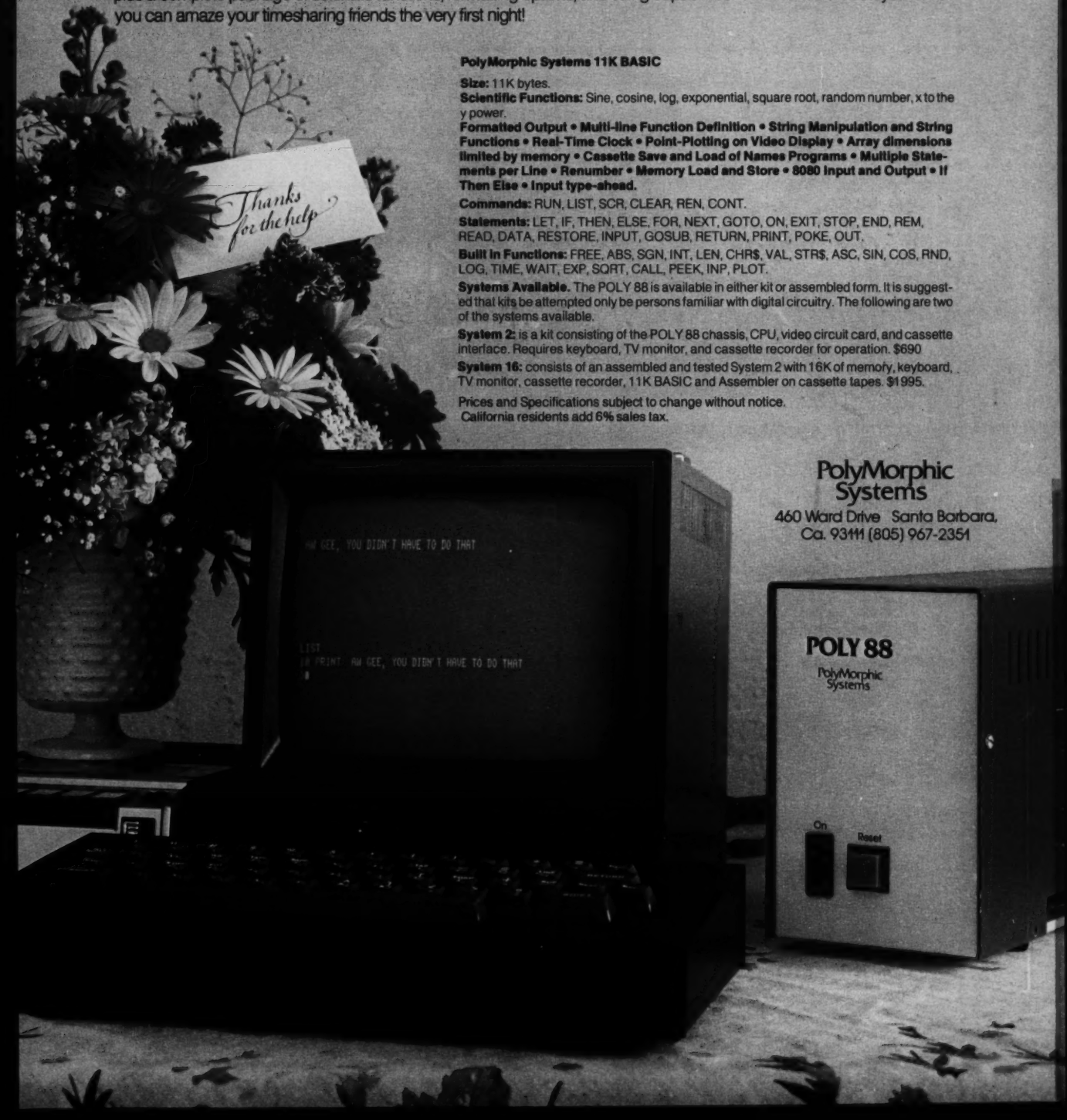
PolyMorphic Systems now offers the complete, assembled, personal computer system—the POLY 88 System 16. A full 16K system with high speed video display, alphanumeric keyboard, and cassette program storage. A BASIC software package providing the most advanced features available in the personal computing market. Features like PLOT and TIME, which utilize our video graphics and real-time clock. Others like VERIFY, so that you know your tape is good before you load another. Or input type-ahead so you can tell your program to run while the tape is still loading (it stores up to 64 characters of commands or question responses to be executed). All these plus a complete package of scientific functions, formatting options, and string capabilities. With the POLY 88 System 16 you can amaze your timesharing friends the very first night!



PolyMorphic Systems 11K BASIC

Size: 11K bytes.
Scientific Functions: Sine, cosine, log, exponential, square root, random number, x to the y power.
Formatted Output • Multi-line Function Definition • String Manipulation and String Functions • Real-Time Clock • Point-Plotting on Video Display • Array dimensions limited by memory • Cassette Save and Load of Names Programs • Multiple Statements per Line • Renumber • Memory Load and Store • 8080 Input and Output • If Then Else • Input type-ahead.

Commands: RUN, LIST, SCR, CLEAR, REN, CONT.

Statements: LET, IF, THEN, ELSE, FOR, NEXT, GOTO, ON, EXIT, STOP, END, REM, READ, DATA, RESTORE, INPUT, GOSUB, RETURN, PRINT, POKE, OUT.

Built In Functions: FREE, ABS, SGN, INT, LEN, CHR$, VAL, STR$, ASC, SIN, COS, RND, LOG, TIME, WAIT, EXP, SQRT, CALL, PEEK, INP, PLOT.

Systems Available. The POLY 88 is available in either kit or assembled form. It is suggested that kits be attempted only be persons familiar with digital circuitry. The following are two of the systems available.

System 2: is a kit consisting of the POLY 88 chassis, CPU, video circuit card, and cassette interface. Requires keyboard, TV monitor, and cassette recorder for operation. $690

System 16: consists of an assembled and tested System 2 with 16K of memory, keyboard, TV monitor, cassette recorder, 11K BASIC and Assembler on cassette tapes. $1995.

Prices and Specifications subject to change without notice.
California residents add 6% sales tax.

PolyMorphic Systems
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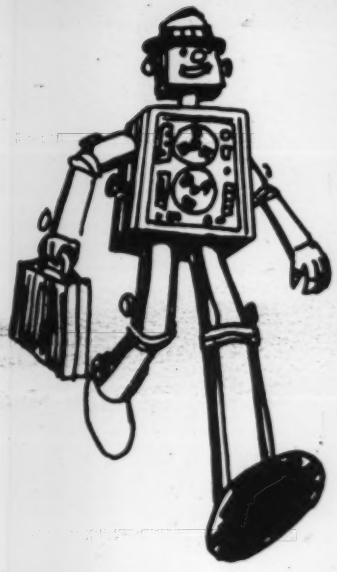

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THE COVER

The cover is an original drawing by George Becker.

The Small Computer

Twenty-five years ago a computer as powerful as the new Processor Technology Sol-20 priced out at a cool million.

Now for only $995 in kit form or $1495 fully assembled and tested you can have your own small computer with perhaps even more power. It comes in a package about the size of a typewriter. And there's nothing like it on the market today. Not from IBM, Burroughs, DEC, HP or anybody else!

It fills a new role

If you're an engineer, scientist or businessman, the Sol-20 can help you solve many or all of your design problems, help you quantify research, and handle the books too. For not much more than the price of a good calculator, you can have high level computer power.

Use it in the office, lab, plant or home

Sol-20 is a smart terminal for distributed processing. Sol-20 is a stand alone computer for data collection, handling and analysis. Sol-20 is a text editor. In fact, Sol-20 is the key element of a full fledged computer system including hardware, software and peripheral gear. It's a computer system with a keyboard, extra memory, I/O interfaces, factory backup, service notes, users group.

It's a computer you can take home after hours to play or create sophisticated games, do your personal books and taxes, and a whole host of other tasks.

Those of you who are familiar with small computers will recognize what an advance the Sol-20 is.

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Tailor the Sol-20 system to your applications with our complete line of peripheral products. These include the video monitor, audio cassette and digital tape systems, dual floppy disc system, expansion memories, and interfaces.

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THE Personal Computing Fair '77

Oh joyous day! The fun, frolic, merchandise, information, ideas, presentation of new products, sharing of dynamite workshops is to happen again this year. It wasn't just a once in a lifetime. For the thousands of you who attended last year—yes, the Personal Computing Fair is again scheduled for the last weekend of August in Atlantic City. For anyone who missed this two day spectacle of computer hobby enthsiasts milling around the packed exhibit area trying to catch all the new products, scribbling notes at the workshops, meeting friends, don't miss it this time around.

The "Computer Hobbyist of the Year" Award will be presented again this year and the selection board is seeking nominations. The person you choose should be an amateur, not someone who's employed in the Field, and should be the kind of person who goes out of the way to support and help other hobbyists, whose efforts have benefitted hobby computing. Think about who you'd like. Nominations are welcomed from either individuals or clubs.

Twenty five homebrew systems will be chosen for display and the three best of these will be awarded big prizes. Send information about the system you'd like to enter, but do it soon. The competition will be keen.

Creative Computing will be at the Fair. Meet you August 27th-28th in Atlantic City, N.J.

John H. Dilks, Fair Director, Personal Computing 77, Rt. 1, Box 242, Mays Landing, NJ 08330.

Computer Science Education Symposium

The eighth Technical Symposium on Computer Science Education will be August 4-5, 1977 at University of Southwestern Louisiana Conference Center, Lafayette, LA. The symposium will provide a forum for educators, administrators, students, and interested persons, to discuss current issues, research, and problems in computer science education.

Contact: Terry Walker, Program Chairman, P.O. Box 44330, USL, Lafayette, LA 70504.

Computer Curricula Workshop

If you teach computer science or computer engineering, or both, here's an opportunity to get together with others in your profession. The workshop on the new four-year computer science and engineering curricula, of the Model Curricula Subcommittee of the IEEE Computer Society, will be held June 6-7, 1977, at the Quality Inn/Fort Magruder, Williamsburg, Virginia.

Attendees will take part in working sessions on implementing the curricula. Immediately after the Workshop will be a tutorial on how to teach microprocessor laboratories.

There will also be sessions of short papers on undergraduate programs including, but not limited to: course and subject integration techniques, special techniques for implementing the curricula, laboratory and project manuals, demonstrations of logic and microprocessor/microcomputer laboratory materials or equipment, analysis of curricular material, continuing education, self-assessment, etc.

Travel & accomodations: Gerald Engel, Dept. of Computing and Statistics, VIMS, Gloucester Point, VA 23062.

Call for Presentations

1977 CONVENTION OF NATIONAL ASSOCIATION OF COMPUTER APPLICATIONS TO LEARNING (NAUCAL) to be held in Dearborn, Michigan, on 2-5 November, 1977. The convention will focus on educational computing, simulations in education, instructional materials, and teaching strategies. Sessions that describe and illustrate computer applications in learning will be given special consideration. Our own Dave Ahl will be giving a feature presentation at this convention.

Individuals who would like to present, or who would like to suggest others who could present, may write to John S. Camp and Larry Smith, Conference Cochairmen, Wayne County Intermediate School District, 33500 Van Born Road, Wayne, MI 48185.

Personal Computing at 1977 NCC

A Personal Computing Fair, scheduled to run at the National Computer Conference June 13-16, will feature operational displays and demonstrations of non-commercial projects. More than 100 small computing systems are expected to be displayed featuring hardware and/or software implementations, games, recreation, music, art, amateur radio, as well as scientific and general applications. Prizes and awards will be presented in recognition of outstanding achievement.

The conference program will feature an indepth examination of personal computing on Wednesday and Thursday, June 15-16. Two three-hour panel sessions on Wednesday will examine *Personal Computing — Past, Present and Future* and *Hardware for the Computer Hobby Market.* Thursday morning will feature a three-hour panel covering *Personal Computing Software* with the afternoon devoted to the presentation of papers relating to personal computing plus a concluding panel on *The Future of Retail Computer Stores.*

Plans are also underway to bring together various special interest groups in personal computing for a series of informal sessions on such topics as the building of computing kits, debugging software, use of assembly language, input/output interfaces, cassette and disc storage, and software standards. In addition, plans are being developed for a "National Club Congress" to enable representatives of clubs from throughout the nation to exchange ideas and discuss issues relating to their activities and programs. Among expected topics will be whether or not a national personal computing association is needed, and if so, how it might be formed. Related topics are expected to include hardware/software standards, a possible national program library interchange, and the establishment of educational seminars.

In addition, the '77 NCC will feature a commercial exhibition by equipment manufacturers and suppliers of personal computing products and services.

Information on the '77 NCC may be obtained from AFIPS Headquarters, 210 Summit Avenue, Montvale, New Jersey 07645 or by calling 201/391-9810.

Games Convention

Ideas for new computer games and a weekend orgy of game-playing are in store for attendees at the seventh annual Cincinnati Games Convention, June 15-17. Program includes open gaming and 50-75 formal events encompassing games of strategy said to appeal to game-players, designers, computer hobbyists, etc. Location is Junior Achievement Hall of Free Enterprise, near highways I-71 and I-275 in northeast Cincinatti, one block south of Cornell Road.

Contact: Cinci Con VII, c/o Boardwalk, 1032 Delta Ave., Cincinnati, OH 45208. (513) 871-2110, 10 AM - 6 PM.

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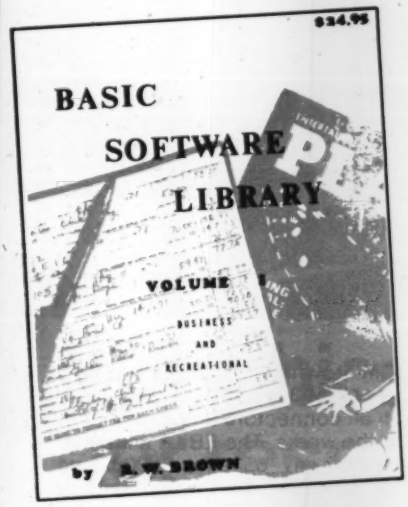

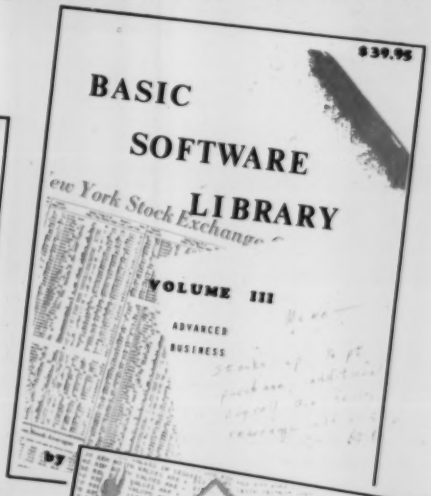

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This library is the most comprehensive work of its kind to date. There are other software books on the market but they are dedicated to computer games. The intention of this work is to allow the average individual the capability to easily perform useful and productive tasks with a computer. All of the programs contained within this Library have been thoroughly tested and executed on several systems. Included with each program is a description of the program, a list of potential users, instructions for execution and possible limitations that may arise when running it on various systems. Listed in the limitation section is the amount of memory that is required to store and execute the program.

Each program's source code is listed in full detail. These source code listings are not reduced in size but are shown full size for increased readability. Almost every program is self instructing and prompts the user with all required running data. Immediately following the source code listing for most of the programs is a sample executed run of the program.

The entire Library is 1100 pages long, chocked full of program source code, instructions, conversions, memory requirements, examples and much more. ALL are written in compatible BASIC executable in 4K MITS, SPHERE, IMS, SWTPC, PDP, etc. BASIC compilers available for 8080 and 6800 under $10 elsewhere.

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al... editorial... editor

Two trends dominate hobby computers today. One is for computer freaks, and involves advanced hardware. Such as an Altair-compatible board that will store digitized versions of your voice in "training" mode, and then, in speech mode, when it recognizes your voice speaking one of the previously recorded words, will cause that word to be printed (this is coming up in 1977). There are already computer boards that synthesize speech. So it won't be long before computer freaks will be trying to get one computer to talk to another, not through wire, but by voice!

Other computer-freak areas involve advanced graphics, computer music, interfacing to a breadboard, digitizing the output of a TV camera, etc. So much time is spent on getting these devices to work, that very little time is actually spent by these hobbyists on computing. The emphasis here is on gadgeteering, on a constant search for the far-out and complex.

The other trend is more and more toward the average consumer's use of hobby computers. This means a certain amount of using all-on-one-board machines such as the KIM-1, EBKA 6502 Familiarizor, and EPA 68, programmed in assembly language. There are more of these all-on-one-board type of hobby computer than any other, one reason being that it's the simplest complete computer in a single package, with a minimum of parts, and is thus much easier for a manufacturer to design and produce than the more complex multi-board machines such as the Imsai 8080 or Digital Group system. For the manufacturer, there's very little labor involved, no sheet-metal work, no point-to-point wiring, and no construction manual to have to supply. A KIM-1 offers the hobbyist the cheapest way to get his feet wet, to learn the basics of computing at minimum cost, without the need for an external keyboard, or connection to a TV set or printer.

Some of these all-on-one-board computers are so simple and cheap that they'd be hard to expand, and are fine for the person who's quite sure all he wants is to learn the elements of computing without having to put too much money into a machine he might not use much after he figures out how it works.

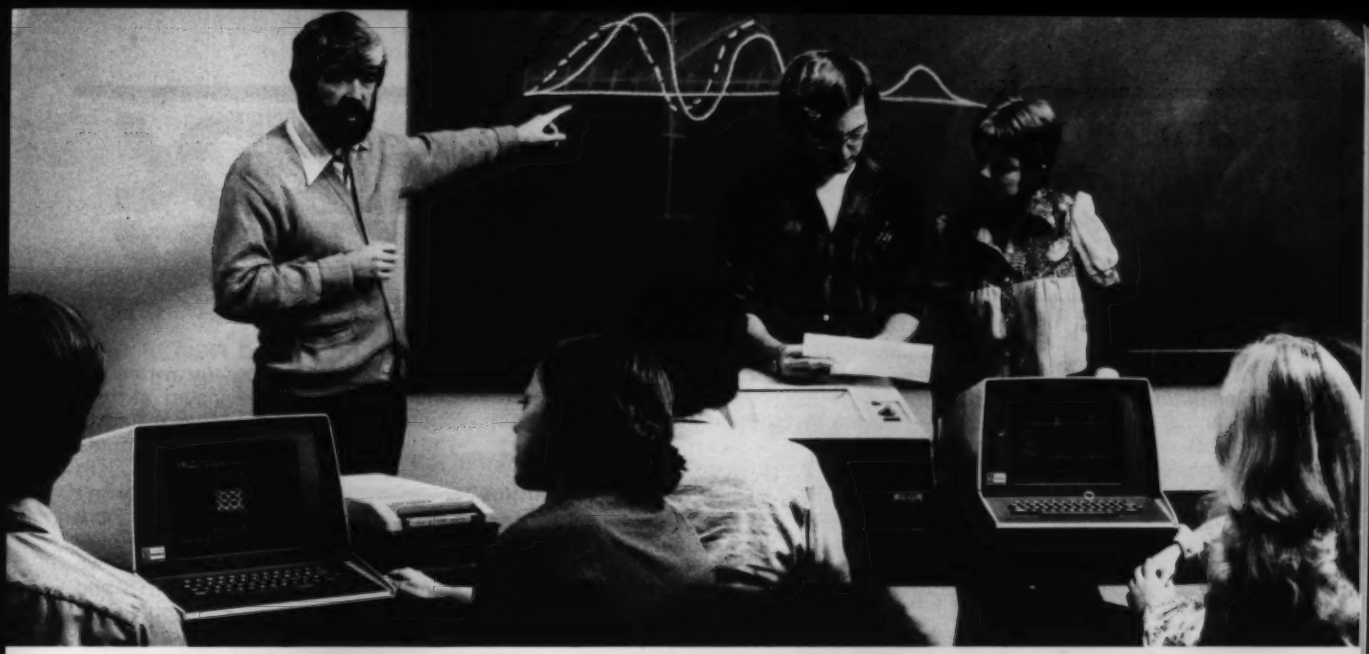
For those who think they may want to expand their computer so as to be able to write longer programs, or to hook on an alphanumeric keyboard or cassette memory system, etc., several of these "compacts" have add-on boards. KIM-1 owners can buy the KIM-2 4K RAM memory board, or KIM-3 8K memory. KIM-4 is a 6-slot motherboard with all connectors and a regulator. And further KIMs are in the works. The EBKA expander board, which will "expand any 6502 or 6800-based microcomputer," can be bought as an empty board, or with any or all of seven options, including kits for a PROM programmer, 4K RAM, 2K PROM, baud-rate clock and interfaces for serial, parallel and dual-cassette operation.

A much more important average-consumer trend is to the wired-only computer that can be programmed in BASIC. As the hobby market appeals to more and more non-technical people, it will have to provide this high-level language, since such people will be interested in programming, and not at all in assembly language, which is too tedious and time-consuming for all but the computer freak. As it turns out, incidentally, there are *very* few hobbyists who are really into heavy assembly-language programming; most of them use BASIC.

Aimed directly at the mass computer-hobby market is the $495 PET 2001 table-top computer, with 9-inch TV screen, built-in audio-cassette unit, full keyboard and numeric keypad, 4K RAM user memory, and BASIC interpreter in 12K ROM, shown in prototype at the January 1977 Consumer Electronics Show in Chicago, and made by a calculator manufacturer (Commodore) that recently bought an IC manufacturing company (MOS Technology, makers of KIM-1). Another calculator manufacturer is said to be working on a similar home computer, although more expensive: with 32K, $2,000.

This is where the major hobby-computer market of the future lies, not in the far-out hardware, but in an all-in-one-box computer that sells for less than $1000. The user won't care if the MPU is a Zilog Z-80 or an Intel 4004. He wants to program, and he needs to be supplied with plenty of software and with plenty of tutorial material to teach him how to use the software and to write his own programs. A couple of the larger hobby-computer manufacturers are already considering hard-wired BASIC computers. This means a BASIC interpreter in some form of read-only memory. 1977 should see *several* new BASIC machines, assembled only, ready to run, for less than $500.

Stephen B. Gray



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Random Ramblings
Random Ramblings
Random Ramblings
Random Ramblings

David H. Ahl

In my position as Publisher of *Creative Computing*, general gadfly of computer games, and Marketing Communications Manager of AT&T, I run into a lot of interesting people and information. Let me share some of it with you. If details are sometimes hazy (or, heaven forbid, incorrect) it's probably because I didn't understand what I was hearing or because I was asked not to violate a confidence.

Cassette Software

Creative Computing has entered into a joint venture with Technical Design Labs in Princeton to produce and market software on cassettes. Frankly, at this point our biggest problem is determining what cassette formats and which languages the software should be in. We think we've defined the 4 or 5 most popular cassette format/Basic language combinations and expect to offer tapes in 3 or 4 of the most popular combinations starting this summer. *Creative*'s contribution will be mostly games and simulations which will be offered on cassettes, each containing from 5 to 10 programs with an accompanying booklet of instructions and listings. There will also be cassettes of word processing, business and accounting programs. Target retail price is $10 per cassette.

Optical Bar Code Software

Several companies are on the verge of marketing an optical bar code reader in the under $50 range. At this point, the most widely used bar code is that found on grocery and department store products. Unfortunately, it doesn't have provision for the type of check sums one would like for long pieces of code. Carl Helmers has proposed a hobbyist standard which he described in the Nov. '76 and Jan. '77 issues of *Byte*. Also, pages of bar codes have been appearing in *Byte*. The standard that Carl proposes meets most of the hobbyist requirements and it is *relatively* easy to produce. It is space-consuming however; an 8½ x 11 printed page can hold only about 50 lines of 40 to 50 characters each, i.e., 2000-2500 characters per page. We'll be running some programs in future issues of *Creative* in optical bar code. Let us know your reaction.

Hit Records

As long as we're discussing software distribution media, consider the record (45 or 33⅓ rpm). Again, I should credit the idea to Carl Helmers who was the first one I heard mention it. Surely I'm jesting! No, I'm not. The cost to press a 7" record is about 50¢ in low volume; this would translate (or escalate) to a selling cost of $1.50 to $2.00. Whereas a tape cassette costs $4.00 plus to produce and has to sell for $10 or so. Maybe we'll try one and see if it works.

New Machinery

Watch for a terrific new CPU to be produced by a joint venture between Parasitic Engineering and George Morrow of Morrow's Stuff. In contrast to the simple no control or one control front panel, this goes the other way. From the front panel you'll be able to examine and deposit in all registers, single step, *slow* step, and look at any I/O port and alter it. Given Parasitic's involvement, we can expect a *BIG* power supply.

A new entry from Sykes Datatronics (makes plug compatable cassettes and floppy discs for DEC, DG and other minis) will use a 6502 MPU, a Sykes floppy (of course), keyboard, and screen. A nice combination. They've been selling hundreds of them as an editing terminal but haven't, until now, offered Basic or marketed the device as a general-purpose system. Somewhat pricey at this point, but maybe with volume it'll come down.

Pioneer Hackers and Gamers Convention

Karl Zinn at UM proposed that *Creative* should sponsor a convention to bring together all the early pioneer hackers to one place for a huge space war shootout. People like Alan Kay, Steward Brand, Terry Winograd, Bob Albrecht, Monty Newborn, Lee Felsenstein, Ralph Gorin, Alan Kotek, Steve Russell, Bruce Baumgart, Peter Deutsch, et al. (Where are all you bums anyway?) Others could attend at their own risk. Any interest out there?

Doctor, Have You Seen Eliza?

Eliza and Doctor, as some of you probably know, are just two versions of one computer program written originally by Joe Weizenbaum at MIT. Doctor was a program that talked to you which essentially took your inputs and turned them around into questions to probe you further. I won't take the space to describe it here (couldn't do it justice) other than to say that we have a version in Basic that we think we can get going in MITS and SWTPC Basic and hopefully publish in the next issue. You'll love it!

Bubble, Bubble

Bell labs and AT&T are keeping a very low profile these days, what with Antitrust suits and the reopened FCC Computer Inquiry and real competition. Hence, there wasn't much ballyhooing about the first bubble memory chips going into service in a recorded message machine (tells callers when they goof). The voice is recorded in digitized fashion and is programmed to automatically respond to caller errors in a huge number of different ways.

However, the interesting thing is that each itty bitty chip holds 68,000 bits, so instead of a board for 8K bytes of storage, it's now in one chip. Power consumption is incredibly low. Hopefully, they'll be on the open market in 2 to 3 years.

The Fine Print

For those of you into reading the fine print on contracts, magazine mastheads, etc., you might have noticed that our editorial address is now 51 Dumont Place, Morristown, New Jersey. For the first time since we started, we're finally all (mostly) under one roof in our very own building. (Yes, we could call it the Creative Computing Building, but that seems a bit pretentious.) Not only is the editorial staff headquartered there, but also the administrative and order processing group and our book service. If I get around to taking some photos we'll show you our new home in some future issue. At the moment it needs lots and lots of work, so if you drop in to visit, bring a hammer and saw.

There are also some new names on the masthead who I'll introduce to you next issue.

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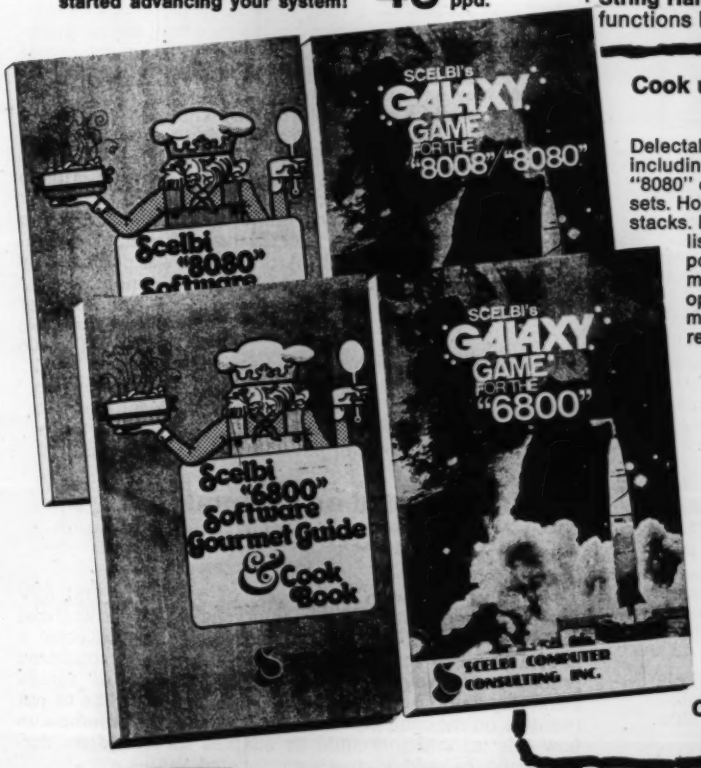
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Go Versus Go-Moku

Dear Editor:

I trust you will receive many notes of protest like this one but I must add my voice to those who object to your equating Go with Go-Moku (bottom of p. 80, Jan-Feb 1977).

Go is to Go-Moku as chess is to reversi; they may be played on the same board, but all similarity ends there. The object in Go-Moku is to get precisely five stones in a row (in Japanese, go-moku = five stones); the object in Go is less clearly defined as acquiring clear title to the largest number of open points, where "clear title" is a vague concept involving one's ability to choke any attempts by an opponent to play in such a region.

If the game fragment illustrated in your thoughtless footnote were, in fact, a game of Go-Moku, black would have no "best move." He would be forced to resign because white has an open four (right centre); a play on either side by black still results in a win by white.

However, any child can see at a glance that this is a game of Go. While in Go one tends to play in the corners and on the side, In Go-Moku one tends to play in the centre, where there is more "elbow room."

Peter N. van den Bosch
5-5751 Yew St.
Vancouver, B.C., Canada V6M 3Y5

More About Go and Go-Moku

Dear Editor:

In the article "Train Your Computer To Be A Go-Moku Champion" by Lawrence Mazleck (page 80), either Mr. Mazleck or (more probably) the person who inserted the diagram in the lower left corner is quite mixed up about Go-Moku and Go. The rules in the main article are certainly for Go-Moku, but of Go; and contrary to the remark that "Go-Moku is frequently known as just Go" there is no comparison. Of course they are both played on the same board with the same pieces, and they are more like each other than either is like poker or football; but you'd be more accurate if you were describing checkers and said "Checkers is frequently known as Chess." Speaking of Chess, Edward Lasker (who I believe knew something about that game) describes Go in an appendix to his book "Modern Chess Strategy" and says that it is unquestionably the greatest of all strategic games, including Chess.

Japan is the place where Go has been played most for the last 1000 years or so (mostly, unless I am much mistaken, without the use of computers); but before that it was known in China as Wei-Chi, and appears in written records from before that 1000 B.C. as an already widely played game. I don't know how old Go-Moku is, but I doubt there is anywhere near the wealth of written records as there is for Go; I believe that in Japan now it is often used by Go players as a light interlude (which may account for the use of the same pieces and board).

I realize that there is quite a difference between programming a computer to play a game (which is more the interest of this magazine) and playing the game yourself; a good programmer may have little or no interest in playing the game personally, while a master-player may know nothing about programming. But I couldn't resist trying to set the record straight a little. There isn't too much written in English about Go (if you read the language, all you need to do is subscribe to just about any large Japanese newspaper) but there are at least two introductions and maybe more; if you want to learn something about the game, besides the Lasker book I mentioned, "The Game of Go" by Arthur Smith was published by the Charles E. Tuttle Company, of Rutland, Vermont.

Trevor Barker
2640 Windsor Street
Salt Lake City, UT 84106

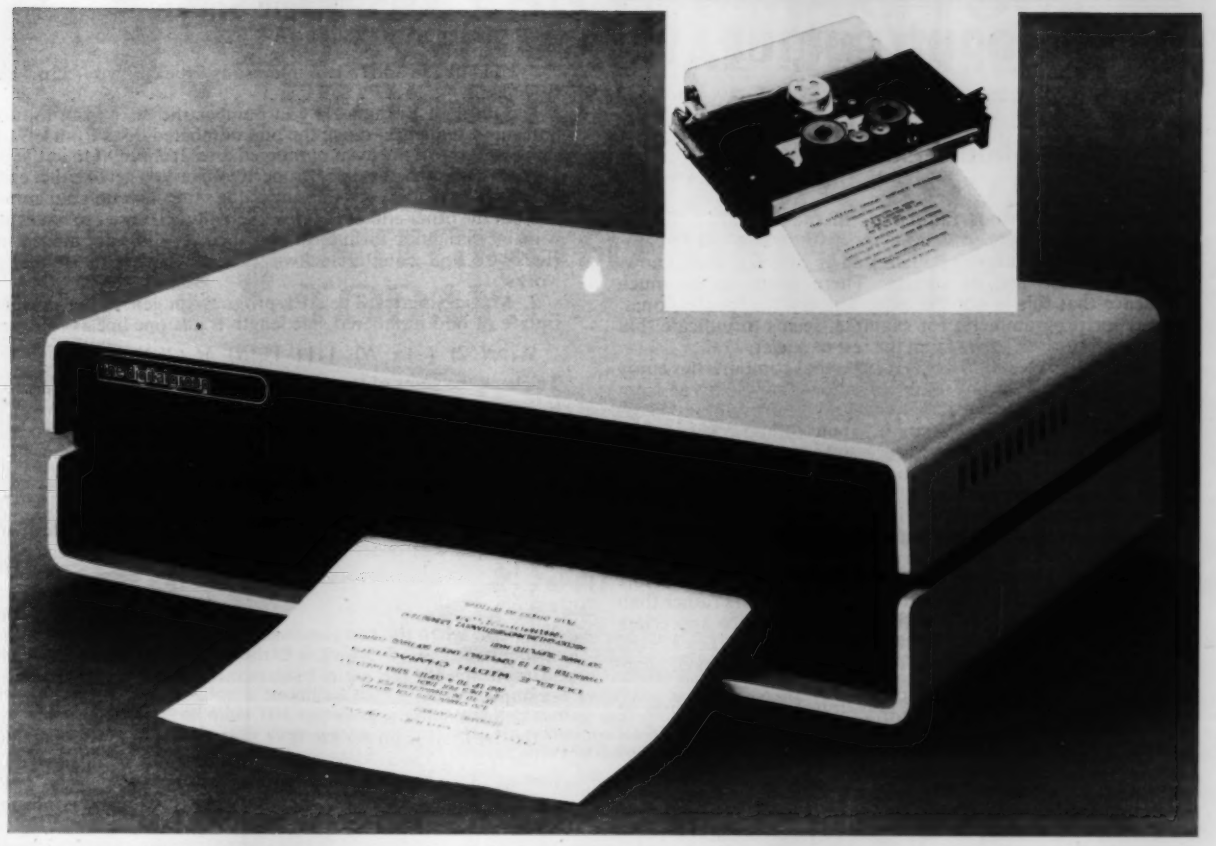
Help Wanted on Computerizing a Genealogy

Dear Editor

My father is now in the process of building a OSI 65V system computer with 12K of memory, cassette interface, and an Extended BASIC software package. He has collected a large amount of genealogical data on our family, consisting primarily of pedigree charts including names of family members, dates, and birthplaces. Now he would like to put this data on the computer he is building. Any information on how this information could be adapted to the system described above would be greatly appreciated.

Robert L. Kintz
104 Council Rock Ave.
Rochester, NY 14610

Ed. Note: Anyone who comes up with a solution for Robert Klintz, please send a copy to *Creative Computing* for possible publication here, as this is an area of growing interest.



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Who Should Educate Whom?

Dear Editor:

Your 'miscellaneous ramblings' in the January-February editorial of CC concerns me. You assume that the 'freaks' who know computers are interested in sharing their knowledge with the rest of society. There seems to be much evidence that this is not the case. The cry for 'professional' status for programmers, for example, seems to indicate that most wish to be set apart from the rest of society.

There have been many observations that computerites enjoy this privity and feel that some power is actually derived from it. This oberservation is largely what Weizenbaum writes of. I'm afraid that the apathy you attribute to non-computerites should be considered more accurately a characteristic of 'insiders.' I think it is difficult to be apathetic about something of which one knows nothing.

The problem of education in data processing is probably one of the greatest impediments to progress at all levels. Your magazine is making one of the most important contributions I have seen. But the 'massive education or re-education' effort you suggest would best be directed toward insiders rather than outsiders. I believe they are the ones who need to appreciate the potential impact of computers on our society; they are the ones who should be educated to their responsibilities of sharing their knowledge with others.

The great debate over what constitutes professionalism in data processing perhaps should revolve about this point of education. Perhaps a professional is one who professes what he/she knows; one who shares his/her knowledge with others so they can be better human beings and be able to cope with the computerized society they find themselves in.

Perhaps CC readers could suggest ways to encourage an interest on the part of computerites who are content to remain freaks.

C. Joseph Williams
3920 Clairmont Ave.
Birmingham, AL 35222

Computer Portrait Systems

Dear Editor:

I would like to get in contact with people who are working on, or have developed, computer protrait systems based on the Altair or Imsai micro-computer.

Richard J. Nelson
18 Severn Ridge Rd.
Annapolis, MD 21401

©CREATIVE COMPUTING

"Why, in case it overflows, of course."

APL Magic Squares

Dear Editor:

I would like to add to two interesting articles in your Jan-Feb 1976 issue.

1. Tower of Brahma. If you number the discs from top to bottom in sequence, move the odd numbered discs from left to right, and move the even numbered discs from right to left, it is very easy to move the discs properly. When you get to either end of the row of pegs, you continue in the same direction but come in from the other end of the row. Actually it is easier to have the pegs in triangular formation and then the discs are moved in clockwise and counterclockwise directions. Try it. It really works!

2. Magic Squares. The APL program for generating a magic square of odd numbered side length is just one line as follows:

```
S ( N 2) (-1+ N) [1](-1+ N) M (N,N)   N¢2
```

To check the sums of the rows, columns, and diagnoals, the four following expressions are used:

```
+/[2]S
  +/[1]S
  +/,Sx(S= S)
  +/,Sx (S= S)
```

One can of course dress up these simple lines with text as desired.

The square of order 3 from the above is

```
8 1 6
3 5 7
4 9 2
```

Note that when the rows are written in one line to produce the sequence 8 1 6 3 5 7 4 9 2 the digits in sequence from left to right specify the digits in sequence from high to low. For example

the 8th digit is a 9
the 1st digit is an 8
the 6th digit is a 7 and so on. Readers may be interested in finding other magic squares with this property.

For even values of N, the above APL expression will not generate true magic squares. The columns will all add to the same total, the rows add to two alternating totals equally spaced from the column totals and the diagonals add to two different totals.

The APL expression above from *APL/360* Reference Manual Second Edition, by Sandra Pakin, Published by SRA.

G. Truman Hunter
31 Overlook Drive
Greenwich, CT 06830

Endless Repeats

Dear Editor:

Products or quotients which endlessly repeat numbers or patterns of numbers have long intrigued me. Some time ago I gave myself the problem: What are the simplest numerators and denominators whose quotients forever repeat each of the numbers 1 through 9? — and I found, of course, that the desired number, divided by 9, endlessly repeats that number. Thus 7/9 = 7777777... The only difficulty was that 9/9 = 1. Here I had to make an infinitesimal adjustment: 89999999999.../9 = 99999999999....

But just the other week I was reading an essay by Nanekal Senrab, an 11th century Arabic mathematician, wherein he reported that, through sheer serendipity, he discovered that any 2-digit number (other than 99) divided by 99 forever repeats that number. Thus 27/99 = 2727272727...(For 99 divide by three nines instead of two, thus: 99/999 = 099099099099....) For three digit numbers (except 999) divide by 999. Thus 987/999 = 987987987..... The number of digits in both numerator and denominator must match. But this can go on ad infinitum, providing infinite delight.

Why dividing a 2-digit number by 99 repeats that numerator was not clear to me until I realized that dividing by 99 is the same as multiplying by its reciprocal which is 01010101... The reciprocal easily illustrates why the rule is true.

I am happy to share this with your readers.

Lakenan Barnes
115 South Jefferson St.
Mexico, MO 65265

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PACKAGE C - THE SOFTWARE DEVELOPMENT PACKAGE: Consists of the Zapple Monitor, Zapple Text Editor and the Relocating Macro-Assembler ..... $ 85

All TDL Software is supplied on paper tape in relocatable hex format along with TDL's comprehensive User's Guides and Manual. Write for prices on disk or cassette media.

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TECHNICAL DESIGN LABS

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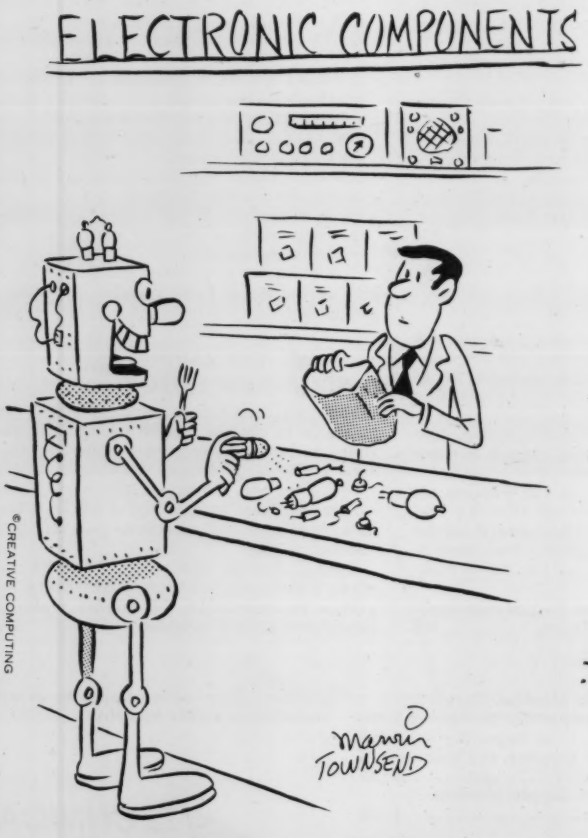
PRINCETON, NEW JERSEY 08540 (609) 921-0321

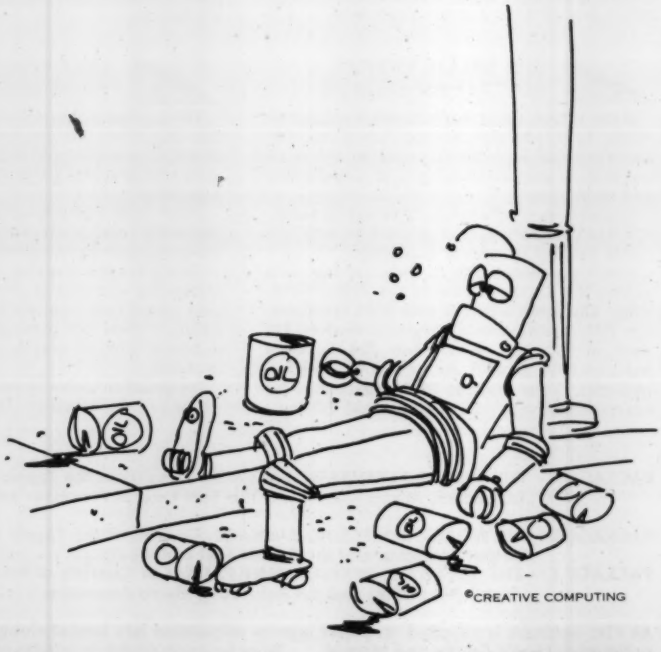
THE LIGHTER SIDE OF ROBOTS

"A box of CMOS please. He gets terrible migranes when he has to do intricate figuring."

"My programmer doesn't understand me."



"Never mind the sack; I'll eat'em here."



Your microcomputer is only as good as its memory

Your microcomputer is... in a manner of speaking... capable of thinking. The amount of information you can store, combined with the access speed, determines the bottom line capability of your microcomputer.

The Midwest Scientific Instruments' FD-8 Floppy Disk Memory System will enable you to get the most out of your microcomputer...6800 or 8080. We have the most complete 6800 disk operating system available today, which interfaces to any microcomputer via a single PIA chip.

When used with the MSI FDOS Operating System...included with purchase...the FD-8 gives your microcomputer a level of performance which can only be matched by larger computers.

You can have program save and load with named, variable length, password protected files at three levels: object code files, source code files, and BASIC files.

It has disk routines which can be used easily by low level assembler language programs as well as high level BASIC programs.

The coresident assembler/editor saves and loads source files from disk, assembles and stores object code on disk, and creates assembly listings on a high speed printer.

You get a full ANSI standard BASIC interpreter* with program load and save, from disk as well as tape, with both random and sequential disk data files. BASIC also has multi-I/O port capability under software control.

And all you need do to access any of these functions is type the appropriate commands on your terminal.

The FD-8 is complete, including all power supplies, cabinet, cables, software, manuals, and documentation.

You can order the FD-8 as a kit for $1,150.00, or wired and tested for $1,395.00.

Visit one of our dealers for a demonstration, or send for our free Catalog of MSI products.

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*MSI BASIC is an additional $85.00

MSI is a dealer for Southwest Technical Products • Mastercharge & BankAmericard Orders accepted

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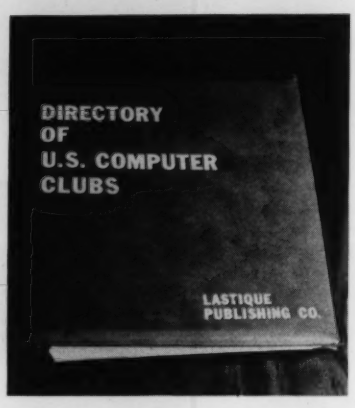
COMPLEAT COMPUTER CATALOGUE

We welcome entries from readers for the "Compleat Computer Catalogue" on any item related, even distantly, to computers. Please include the name of the item, a brief evaluative description, price, and complete source data. If it is an item you obtained over one year ago, please check with the source to make sure it is still available at the quoted price.

Send contributions to "The Compleat Computer Catalogue," *Creative Computing*, P.O. Box 789-M, Morristown, NJ 07960.



ORGANIZATIONS

JOIN FASST FAST

FASST (Forum for the Advancement of Students in Science and Technology) is a non-profit educational student organization representing individual members and chapters throughout the country and abroad. Dedicated to provide information for both the technical and non-technical student, an annual membership brings you: FASST NEWS, a quarterly tabloid covering a potpourri of science and technology developments and policy issues and FASST TRACKS, a quarterly newsletter containing organizational news, resource listings, opportunities for involvement, and listings of regional and national conferences. $5 year.

FASST Headquarters, 1785 Massachusetts Ave., N.W., Washington, DC 20036. (202) 483-2900.

DIRECTORY OF CLUBS

The Directory of U.S. Computer Clubs contains five-cross-indexed sections: Club Profiles, Geographic Locator, Special Interests, Equipment, and a User's Guide. Interested persons can use the directory to find out how others are using their computers, reach persons of the same interests, and obtain solutions to computer problems that others have already solved. Computer clubs wishing to be listed may write for a "Profile Listing Form." The $35 price includes the basic edition plus two updates.

Lastique Publishing Co., P.O. Box 1691, Dept. CC, Austin, TX 78767, (512) 472-6723.

BOOKS AND BOOKLETS

DICTIONARY OF MICROCOMPUTING

This 191-page book defines in easy-to-understand terms all the essential vocuablary needed by students and laypersons to read and understand microprocessor literature (and all the other magazines except *Creative*). Besides definitions, the book includes examples, sketches, diagrams, and tables. Hardbound $12.50.

Garland Publishing, Inc., 545 Madison Ave., New York, NY 10022.

VENDOR LITERATURE

CALCULATOR GUIDE

This 12-page guide to National Semiconductor's hand-held calculators covers ten scientific and business models.

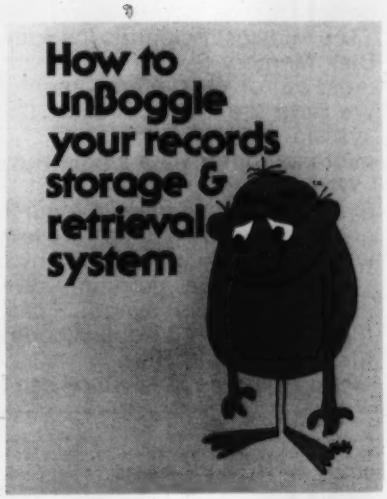
The features of each calculator are described on a page for each of the ten, and a table on the back cover shows which calculator has which features, for instant comparison of 39 major features. Free.

National Semiconductor Corp., 1177 Kern Ave., Sunnyvale, CA 94086.

CASSETTES AND DISKS

The Information Terminals Corp. catalog and spec sheets cover a wide variety of digital cassettes (five series), mini-cassettes, ¼-inch data cartridges, and flexible disks (six types). The company also makes word-processing cassettes and magnetic cards, as well as test instruments, and publishes informative, detailed tech notes on tape handling and storage, certified cassettes and disks, how to select a cassette, etc.

Information Terminals Corp., 323 Soquel Way, Sunnvale, CA 94086.



RECORDS STORAGE AND RETRIEVAL SYSTEMS

All types of records storage and retrieval systems are described in a 24-page brochure from Sperry Univac, Entitled "How to UnBoggle Your Records and Retrieval System," the brochure covers the essentials from indexing to sorting, filing systems, file housing, fire protection, filing aids, filing controls, retention, and centralization versus decentralization. Free from dealers or from:

Sperry Univac Office Equipment Division, P.O. Box 500, Blue Bell, PA 19422.

COMPUTERS

COMPUTER IN A BOOK

Iasis has combined an 8080-based microcomputer and a 250-page programming course into a standard three-ring binder. The ia7301 Computer in a Book is designed for hobbyists and engineers who want to become proficient in programming microcomputer systems. Once mastered, the system can be expanded, from 1K bytes of RAM to 65K bytes, and from 2 I/O ports to 256 ports. The system includes a cassette-tape interace, monitor in 1K PROM, 8 segmented LED displays, 3 LED indicators, 24-key hexadecimal keyboard with six special mode keys and power supply. The ia7301 Computer in a Book, assembled and tested, is $450.

Iasis, Inc., 815 W. Maude St., Sunnyvale, CA 94086.

CROMEMCO Z-1

Cromemco's new microprocessor development system, the Z-1, features the Zilog Z-80 MPU chip, said to be the most powerful microprocessor chip available, plus 8K of RAM memory, 8K of PROM capacity, a PROM programmer, resident monitor in PROM, RS-232 serial I/O interface, and a rugged mainframe with 22 card sockets and a heavy-duty 28-amp power supply.

One option is a wire-wrap board that fits the Z-1 sockets, permitting prototype work on a physically isolated board free of other circuitry. Other support peripherals include a 7-channel analog I/O interface, two-axis joystick with four pushbutton switches, an optical data-digitizing camera that provides a 32 × 32-element picture, and a color graphics interface.

The Z-1 is a ready-to-run system, with a basic price of $2495.

Cromemco, 2432 Charleston Rd., Mountain View, CA 94040.

CROMEMCO Z-2

Cromemco's latest microcomputer, the Z-2, is based on the Z-80 MPU and designed for dedicated applications. Mostly of interest to engineers, but also to hobbyists, the Z-2 contains a 4-KHz CPU card, motherboard with 21 card sockets, and a heavy-duty power supply, with a front panel free of controls or switches, and compatibility with the Altair/S-100 bus. $595 kit, $995 assembled.

Joe McCrate, Cromemco, Inc., 2432 Charleston Rd., Mountain View, CA 94043.

ECD MICROMIND

Several unique features make the MicroMind from ECD a welcome addition to the field of hobby microcomputers. The dot-matrix output characters are defined by software, so standard 5 × 7 or 7 × 9 ASCII, APL, Japanese kana, Greek, Hebrew, or chess pieces can all be handled. And each of the 80 keys on the keyboard is user-defined with software. Keycaps can be removed for changing the legends.

Based on the fast 6512A MPU and using 8K of memory, the current model is supplied in a cabinet, fully assembled, along with separate keyboard and r-f modulator. Software consists of an interactive editor, assembler, monitor, cassette-based file system, and an extended form of BASIC, plus several games. $987.54.

Five options are available: 8K more memory, analog I/O, vectored interrupt, cycle suppression, and memory mapping. MasterMind II includes all five, at $1,386.54.

ECD Corp., 196 Broadway, Cambridge, MA 02139.

MERLIN

THE INTELLIGENT VIDEO INTERFACE

MERLIN is the best ASCII/Graphics board now available for the S-100 bus . . . and at an unbelievable price!

Compare these features to any other video interface:

- ☆ 160H x 100V resolution bit mapping graphics
- ☆ On-board ROM (Monitor/Editor) option
- ☆ 40 characters by 20 lines, character ROM-generated (hardware)
- ☆ Keyboard interface (with power)
- ☆ Programmable modes and display format
- ☆ Serial I/O port
- ☆ Low power . . . only 600ma at +8V
- ☆ Extremely fast (uses DMA)
- ☆ Comprehensive User Manual . . . 200ps
- ☆ American 60HZ or European 50 HZ operation.

Designed-in expandability means maximum versitility at minimum cost. Add-on options now available (in kit form) include:

- ☆ Super Dense Graphics (M320-K) $39
- ☆ Lower case characters (LC) $25
- ☆ Serial-to-parallel expansion Kit (MSEK-K) $45
- ☆ 1500 Baud (software) cassette interface kit (MCAS-K) $29
- ☆ 2K x 8 Mask ROM; graphics, cassette, & extended editing software (MEI) $35
- ☆ 2K x 8 Mask ROM/256 RAM; Monitor Editor Software (MBI) . . $39

The MBI ROM software is designed to allow turnkey operation and sophisticated editing and scrolling.

Ask to see a demonstration of MERLIN at your nearest computer store. Many dealers now stock MERLIN and there is nothing like a hands-on demo for really evaluating a product. We know you'll be sold.

MERLIN Kit with Manual $269
MERLIN, assm'd & tested $349
MERLIN User Manual . . . . . $ 10

For fast information, write us direct! MC and BAC accepted.

MiniTerm Associates, inc.
Box 268, Bedford, Mass. 01730 (617) 648-1200

MULTI-PURPOSE SYSTEM

AMI (American Microsystems, Inc.) has introduced the AMI 6800 Microcomputer Development Center (MDC), which functions either as a system for hardware and software design and development of microcomputer systems, or a general-purpose data-processing system, or an intelligent communications terminal. The system includes a CRT terminal and a dual-drive floppy-disk system with more than 500,000 bytes of on-line data storage.

Standard card modules include MPU, EPROM/ROM, RAM, debug, keyboard/telecommunications, peripheral interface, EPROM programmer, and CRT driver. The center with 16K memory is $10,500.

American Microsystems, Inc. 3800 Homestead Rd., Santa Clara, CA 95051.

SPHERE COMPUTER FOR SMALL BUSINESSES

The 500 series is Sphere Corporation's line of data processors designed to serve the needs of small businesses. The series offers a video display of 2,000 characters, 80 per line, in upper and lower case. Full ASCII keyboard plus keypad and cursor-control keys are standard. Executive control programs are in ROM. BASIC is provided with the hardware. Optional software packages include product inventory control, accounting functions, and mailing lists.

Models range from the 520, a 4K serial-interface intelligent terminal with optional 4K BASIC to make it a stand-alone computer, to the 550, a 52K dual floppy-disk system with extended BASIC and a 132-character printer.

Sphere Corp. 791 South 500 West, Bountiful, Utah 84010.

DATA GENERAL MICRONOVA

The first in-house micro from a mini maker, the microNOVA from Data General is part of a 16-bit family that includes an MPU chip, a CPU board with 4K words of RAM, and the computer itself. The microNOVA MPU is compatible with the NOVA series, and can address 32K words of main memory, as RAM or PROM. Support products include asynchronous and diskette interfaces and a diskette-based operating system. The microNOVA mN601 MPU is $225 each; the CPU/4K board $950; the computer with 4K, $1995.

Data General Corp., Southboro, MA 01772.

COMPUTES IN BASIC

Hewlett-Packard's new 26-pound HP 9831A desktop computer can be used as a stand-alone BASIC computer or linked with peripherals to form systems. Memory is 8K bytes, expandable to 32K. BASIC commands for string variables, input/output (for peripheral control), and advanced programming operations are built in. Optional ROMs are available for working with matrices, plotters, and flexible disks. A high-speed bi-directional tape drive gives an average access time of 6 seconds. A 32-character LED display provides upper- and lower-case alphanumeric readout.

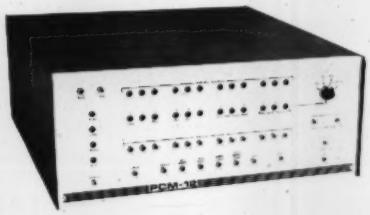
The 9831 is the heart of the new HP 9896A business information management system, which also includes dual flexible disks and a printer.

Inquiries Manager, Hewlett-Packard, 1501 Page Mill Rd., Palo Alto, CA 94304.

CONTROL DATA SYSTEM

Whether used in the classroom, laboratory or office, the Control Data CYBER 18-30 mini-computer-based system supports up to 64 timesharing terminals. The model 18-30 includes dual processors, up to 512,000 bytes of shared main storage, and a large-capacity micro-programmable memory. A system with full complement of peripheral devices that suppports 32 interactive terminals sells for $116,000.

Control Data Corp., Box 0, Minneapolis, MN 55440.



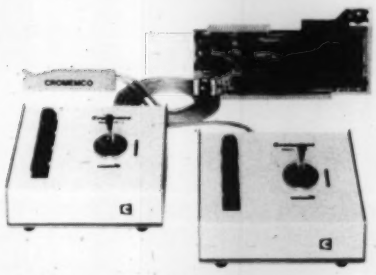
PCM-12A

The PCM-12A is an improved version of the PCM-12, a 12-bit microcomputer designed around the Intersil IM6100 microprocessor by Pacific Cyber/Metrix (PC/M), and fully compatible with DEC's software for the PDP-8E minicomputer. Improvements include a built-in crystal-controlled baud-rate generator, an absolute loader that will directly bootstrap a binary-format tape into any field of memory, "beefed-up" cabinetry and documentation, and addition of floppy disk to the system, so the DEC's OS-8 can be run.

Available interfaces include serial and parallel I/O, high-speed reader/punch (all DEC-compatible), and an audio-cassette recorder interface. Memory modules include RAM and EPROM. Basic kit price, with 1K static RAM, is $799.

Pacific Cyber/Metrix, Inc., 180 Thorup Lane, San Ramon, CA 94583.

PERIPHERALS



JOYSTICK CONSOLE

Cromemco's new two-axis joystick has features not usually found in joysticks. It's a console, with built-in speaker and speaker amplifier for sound effects in games and other applications, and four pushbuttons for cursor positioning, selecting the colors in color graphics, etc. The JS-1 joystick is interfaced to a microcomputer via Cromemco's D+7A 7-channel analog-to-digital I/O card, which is compatible with the Altair bus and which will handle two joysticks. The console is $65 in kit form, $95 assembled.

Cromemco, Inc., 2432 Charleston Rd., Mountain View, CA 94043.

SYNETIC DESIGNS FLOPPY DISK

A ready-to-use floppy-disk system for Altair-bus 8080 microprocessors, the Synetic Designs FDS-2 includes dual floppy drives, controller, interface, power supplies, cabinet, and software. Using ICOM's IBM-compatible Frugal Floppy system together with their executive system, text editor, and assembler, the FDS-2 is delivered without I/O vector assignments, initialization routines or program relocation required of the user. Each diskette stores up to 256K bytes, and one to four drives may be operated from one controller, for a total on-line storage capacity of over one megabyte. The cabinet has WRITE PROTECT switches, and indicators for UNIT SELECT, STATUS, READY, ERROR, and PROTECTED.

Synetic Designs Co., P.O. Box 2627, Pomona, CA 91766.

CARTRIDGE MEMORY SYSTEM

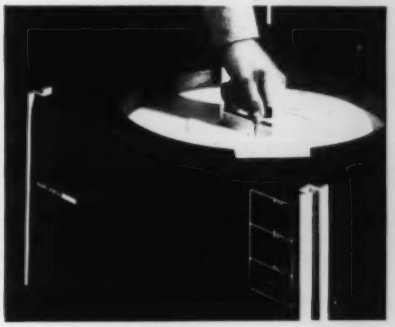
Combining the 3M DCD-100 minicartridge tape drive with the flexibility of a microprocessor-based control system, the GNAT MS-200 system is designed for applications such as data monitoring and storage, process control, or communications. The MC-200 provides RS323-formatted I/O, enabling any RS232 device to plug directly to the DB25 connector on the system. Optional features include parallel I/O, separate parallel input and output lines, expanded serial I/O, independent record and playback baud rates, file-search capability, dual drives, and word-length select. $1930.

GNAT Computers, Inc., 7895 Convoy Court, Unit 6, San Diego, CA 92111.

40-COLUMN PRINTER

EPA's 40C 40-column dot-matrix impact printer comes complete with drive electronics, character decoding and software driver PROMs, power supply and cabinet. The 40C interfaces with 6800 and 8080 microprocessors, and can print 80 characters per second bi-directionally. $450.

Electronic Product Associates, Inc., 1157 Vega St., San Diego, CA 92110.



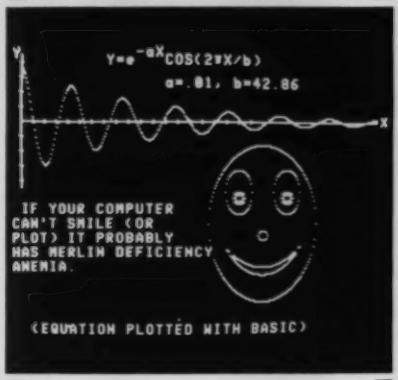
DATA GENERAL CARTRIDGE DISK

The new DG/Disk moving-head cartridge disk series from Data General has two unique configuration features: it allows mixed cartridge disk/diskette configurations, and it can be dual-ported for shared-disk configurations. The subsystems can be selected with 10, 20, 30 or 40 megabytes. The design allows any mix of disk cartridge drives and diskette drives up to a total of four on a controller. A single-drive subsystem with cartridge disk drive, power supply, controller and cabling is $9950.

Data General Corp., Southboro, MA 01772.

SUPER DENSE GRAPHICS

320 Horizontal by 200 Vertical



The MERLIN Super Dense add-on kit provides maximum resolution at a minimum cost. In fact, MERLIN with Super Dense has more capabilities than any other S-100 bus video interface at any price!

Once you've seen 'Super Dense' graphic resolution you'll know there is nothing to compare it to . . . short of spending over $600 . . . and even then you'll not have all of the capabilities of MERLIN with 'Super Dense'.

Super Dense provides true bit-mapping. Each and every point on the screen is controlled directly by a bit in memory. (Requires 8K of system memory.)

ROM character-graphics looked good for a while; then came MERLIN's 160 by 100 bit mapping graphics; and now . . .
320 by 200 bit-mapping graphics! ! !
If you're looking for a graphic display, MERLIN with Super Dense is the best there is. And if you hadn't considered graphics or thought it was out of your price range, consider what you could do with 320 H by 200V graphics and for only $39 extra.

The Super Dense add-on kit to the popular MERLIN video interface is now available with off-the-shelf delivery.
M320-K, Super Dense Kit $39
M320-A, Super Dense Assm. . . $54
See MERLIN ad on previous page.

For information fast, write direct, or see 'Super Dense' at your nearest computer store.
MC and BAC accepted.

MiniTerm Associates, Inc.
Box 268, Bedford, Mass. 01730 (617) 648-1200

TERMINALS

KEYBOARD AND DISPLAY

The KDM/1 terminal with display, by Micon, allows two-way computer-data communication with any RS-232 interface device. It combines in a compact unit a full ASCII keyboard, 32-character alphanumeric LED display, AC power supply, and RS-232 interface. Baud rates are selectable, from 110 to 9600. The plastic case is available in eight different colors. $400.

Micon Industries, 252 Oak St., Oakland, CA 94607.

ELITE CRT TERMINALS

The Elite 1500A is a low-cost alphanumeric terminal featuring plug-to-plug compatibility with 33 and 35 Teletypes when the RS-323C interface is used. The 1500A operates only in the "roll" mode; an alarm signals, when the 12-inch screen is almost full, that the top line of data is about to be lost. Display capacity is modular, and ranges from 32 characters on 8 rows to 80 characters on 24 rows. Data rate is switchable from 50 to 4800 bps. Prices range from $1250 for the 32 × 8 display, to $1430 for an 80 × 24 display, with six other intermediate display formats.

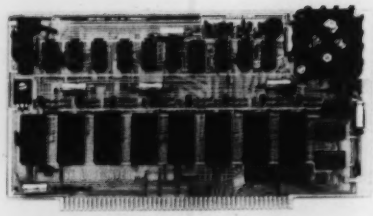
Datamedia Corp., 7300 North Crescent Blvd., Pennsauken, NJ 08110.

MISC. HARDWARE

VIDEO BOARD

The VB1 video board, plug-in compatible with the Altair/S-100 bus, features on-board DIP-switch selection of 32 or 64 characters per line, with 16 display lines; upper and lower case and Greek alphabet with other interchangeable fonts available; and parallel and composite video outputs to video monitor or TV set. $189.95 kit, $269.95 assembled.

Cybercom Div., Solid State Music, 2102A Walsh Ave., Santa Clara, CA 95050.

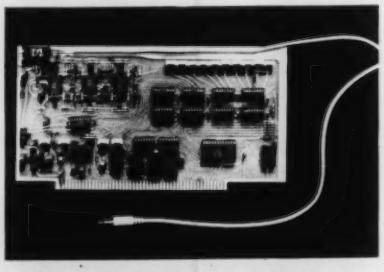


CROMEMCO BYTESAVER AND PROM PROGRAMMER

Cromemco's Bytesaver memory board, which fits the Altair/S-100 bus, provides a simple, easy way to store computer programs in programmable read-only memory (PROM), on board that will hold 8K bytes. The Bytesaver transfers programs from non-permanent RAM memory to permanent PROM memory, and will hold 8K BASIC in its maximum capacity of 2704 or 2708 PROMs. The full 8K of PROM can be loaded into computer RAM in less than a second.

Software provided in a 2704 PROM controls transfer of the computer RAM contents to the Bytesaver PROM. The Bytesaver is $195 kit, $295 assembled.

Cromemco, 2432 Charleston Rd., Mountain View, CA 94043.



SPEECH SYNTHESIZER

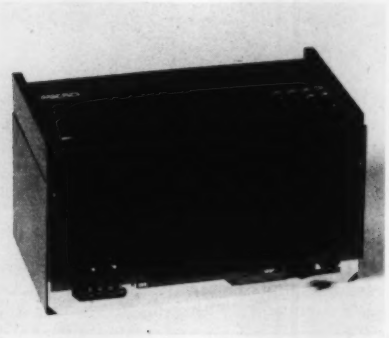
The Model 1000 Speech Synthesizer is Ai Cybernetic Systems' hardwired analog of the human vocal tract. Various portions of the circuit simulate the vocal cords, the lungs, and the variable-frequency resonant cavity of the mouth, tongue, lips and teeth. All the information necessary to produce the speech sounds of American English is in ROMs. Input to the 1000 is a string of ASCII characters, each representing a phonetic sound or phoneme; "I AM A TALKING ROBOT" is programmed as "&&IE AM AE T)..KEN RO.B)..T." The Altair/S-100-bus-compatible 1000 is $325. A demonstration cassette is $5; a programming manual, $4.

Ai Cybernetic Systems, P.O. Box 4691, University Park, NM 88003.

M&R CPU & 8K RAM

This 6800-based central processor unit and 8K memory-board combination from M&R has been specially designed for difficult applications. Standard-sized 4½-inch-wide boards conform to widely available card racks, and 22-pin double-sided edge connectors facilitate interconnect. The CPU can operate by itself with up to 384 bytes of on-board RAM (plus MIKBUG ROM) or with up to seven 8K memory boards. $245 each.

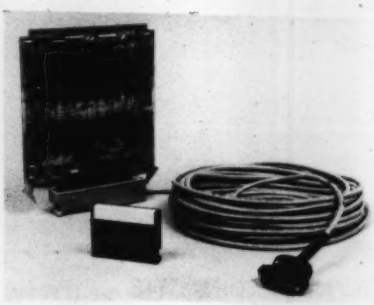
M&R Enterprises, P.O. Box 61011, Sunnyvale, CA 94088.



DATA-CATCHER

Providing single-step operation of the Micro-68 line of 6800 microprocessor prototype development systems, the Data-Catcher from EPA captures address and operand after the completion of each machine instruction and displays the data on an integral 6-digit hex display. This feature provides for easy debugging of new programs written by the user. $140.

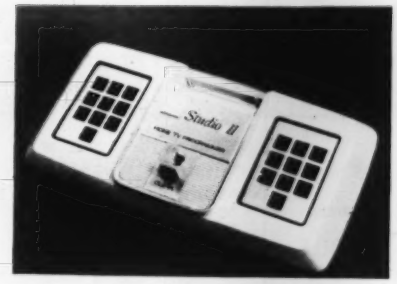
Electronic Product Associates, Inc., 1157 Vega St., San Diego, CA 92110.



LINK AN HP 1000 TO AN IBM COMPUTER

With a new remote job entry subsystem (RJE), the Hewlett-Packard 1000 computer can communicate with IBM 360 and 370 batch-oriented computers much like an IBM 2780 data-transmissions terminal. It gives the HP 1000 user at a remote site the full power of an IBM batch system at the central DP department for large-scale computation and report generation. It also provides the convenience of storing large amounts of data from real-time acquisiiton, control, automatic testing and data-base management tasks. The new RJE/1000 software/hardware package is $4500.

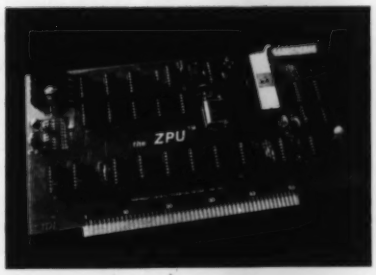
Inquiries Manager, Hewlett-Packard Co., 1601 Page Mill Rd., Palo Alto, CA 94304.



HOME TV PROGRAMMER

RCA's entry into the video game field is a home TV programmer called "Studio II," which can reproduce games and instructional material on the screen of any size TV set. Heart of the programmer is the RCA COSMAC microprocessor, which controls the five games built into the console as well as those contained in plug-in cartridges. The first three cartridges are called TV School House I (math and social-studies tests), TV Arcade I (Space War), and TV Arcade II (Fun with Numbers). Studio II is $149.95; the TV Arcade cartridges are $14.95.

RCA Distributor and Special Products Div., Deptford, NJ 08096.



Z-80 CPU CARD

Said by Technical Design Labs to be the first Z-80 CPU card compatible with the Altair bus, the ZPU is designed to replace the current 8080 or 8080A CPUs and "effectively increase the power of these microcomputers by up to 500%." Available software includes both 1K and 2K monitors, a line- and character-oriented text editor, relocating macro-assembler, and 8K BASIC. Future releases include a TECO text editor, a word-processing system, and a FORTRAN IV compiler. The ZPU is available as a $269 kit and also assembled and tested.

Technical Design Labs Inc., Research Park, Bldg. H. 1101 State Rd., Princeton, NJ 08540.

MEMORY AND MORE

Electronic Control Technology now available on exceptionally low power BK static memory Board for the Altair S1100 bus. $295 Kit or $350 wired and tested.

Also available are a rugged construction ECT-100 Card Cage which fits the industry standard 19" cabinetry occupying 7 RETMA increments (12.25 inches). It comes with the MB-20 Mother Board. $100 or $60 for the Mother Board Alone.

Electronic Control Technology, PO Box 6, Union NJ 07083.

MUSIC FOR MICROS

A music board for the Altair/S-100 bus, along with a high-level music language, are available from Cybercom, a division of Solid State Music. The SB1 Music Board generates complex waveforms because attack and sustain reside in hardware, rather than in software. The music language allows the user to input notes via keyboard. The envelope, frequency, 16 levels of volume and nine octave levels are all software selectable. $250 kit, $300 assembled; software included.

Cybercom Div., Solid State Music, 2102A Walsh Ave., Santa Clara, CA 95050.

SOFTWARE

MIKADOS

For developing small to moderate-size programs on a 6800-based microcomputer, Inpro Micro Systems has a low-priced Mini Instant Keyboard Assembler, Debug, and Operating System, or MIKADOS. Occupying 2.5k bytes of memory, it generates object code for all 72 instructions of the 6800 with all addressing-mode variations. Eighteen directives permit the user to: input/output ASCII characters, input hex characters and output formatted hex characters, output formatted object code and label table, move data from one area of user memory to another, clear all or any portion of user memory, define user memory space, start execution of user program, set/clear breakpoints and monitor points, and more. $12.95, including manual and hex object-code listing.

Inpro Micro Systems, P.O. Box 7776, Van Nuys, CA 91409.

BASIC INTERPRETER

The complete documentation, and a complete, annotated assembler listing of a BASIC interpreter for the 8080 has been published in *Dr. Dobb's Journal of Computer Calisthenics & Orthodontia.* As "pure code," it may be placed in ROM or PROM, and requires five kilobytes of storage for the interpreter, which includes a complete floating-point package.

Subscriptions and reprints: PCC, Box E, Menlo Park, CA 94025.

PARALLEL I/O BOARD for only $45 ! ! !

Made possible by the designed-in expansion capabilities of the impressive MERLIN Video Interface.

Aside from general purpose uses, the designers at MiniTerm anticipated Graphics and Graphics games and the problem of control interfacing. The MSEK (MERLIN Serial Expansion Kit) provides:

Three parallel input ports
Three parallel output ports

These can be used for interfacing joysticks or game controllers or parallel I/O devices. And the price can't be beat! The MSEK mounts inside your keyboard and connects to MERLIN through the keyboard cable.

SPACE WAR!

Also available from MiniTerm is the first real raster graphics "Space War" game for the personal/hobby market.

"Space War" gives the user control of rotation, accelleration, and firing of missiles for two space ships. When used on the MERLIN video interface with 'Super Dense' add-on option (320 x 200) the game provides more excitement than any BASIC version of "Space War" or any of the standard TV games!

A delux version of "Space War" is also available which allows selection of ship dynamics to simulate cars, tanks, boats, etc. and allows the user to draw his own 'ship'.

Space War (SPW) $25
Delux Space War (DSPW) $35
(Add suffix -T for Tarbell tape, or -P for INTEL hex paper tape.)

A complete source listing is available for an additional $10 for either game.

Write for full description, or better yet, play a few rounds at your local computer store. But be prepared to stay a while. There is likely to be a line and you may become addicted.

MC and BAC accepted.

MiniTerm Associates, Inc.
Box 268, Bedford, Mass. 01730 (617) 648-1200

ZAPPLE PACKAGES

The Zapple line of microprocessor software from Technical Design labs is written for the Z-80 MPU. The five software packages currently available are: 2K monitor with 27 instructions; 3K text editor; 8K relocating macro-assembler; 8K BASIC that includes LIST VARIABLES, TRACE and RENUMBER; and a 3K word-processor, SCRIPT, which includes automatic paging, justification, concatenation, spacing, title and subtitling. Each package is $150.

Technical Design Labs Inc., Research Park, Bldg. H, 1101 State Rd., Princeton, NJ 08540.

MENTEXT

Mentel announces a 30-day free trial to introduce the MENTEXT System to installations interested in distributed processing without distributed processors. MENTEXT incorporates interactive text editing, remote job entry and retrieval, dataset and catalog management, document processing and an interpretive programming language into a single system. MENTEXT can be used to edit accounting data, correspondence, source programs, test data, JCL statements, etc. MENTEXT supports 3279, 2741 and Teletype-compatible terminals.

Mentel, Inc., 459 Hamilton Ave., Palo Alto, CA 94302.

INTERACTIVE GUIDANCE FOR STUDENTS

SIGI is a computer-based System of Interactive Guidance and Information designed to help students make career decisions. The main purposes of SIGI are to increase students' freedom of choice, to develop understanding of the elements involved in choice, and to improve their ability to make informed and rational career decisions. SIGI is written in BASIC-Plus, designed to operate on PDP-11 computers under the RSTS/E monitor, and consists of six subsystems: values, locate, compare, prediction, planning, and strategy.

Ms. Katharine Darlington, Educational Testing Service, Princeton, NJ 08540.

DEC APL COMPILER AND TERMINAL FOR PDP-11 LINE

APL-11, a compiler compatible with Digital Equipment's entire line of PDP-11 minicomputers, has been developed by DEC, along with a modified version of a standard terminal to work with the unique set of symbols required for APL.

According to DEC, the introduction of APL-11 marks the first time APL has been made available for an entire family of minicomputers. Compatibility runs from the floppy-disk-based PDP-11/3V03 LSI configuration to the top-of-the-line PDP-11/70 system, and includes both RT-11 and RSTS/E environments.

The LA37 terminal, a variation of the standard LA36 printer terminal, has a keyboard that includes the APL symbols along with alphanumerics, and a dot-matrix printhead. Users with LA36 terminals can have them adapted for APL.

The APL-11 compiler will have a $1,650 license fee, and the LA37 terminal is $3,330.

Digital Equipment Corp., Maynard, MA 10754.

MISCELLANEOUS

FLOWCHART SYMBOLS

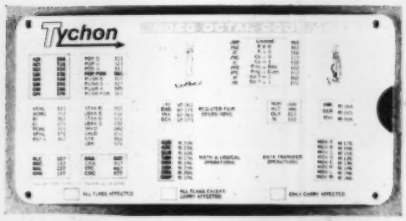
Just stick 'em and peel 'em off, say the creators of Fickled Thinking Aids, which are peelable program flowchart symbols with sticky backs. Base-boards are available in sizes from 8½ by 14 to 22 by 34 inches, and the 17 different symbols range from input/output to display. Write on both base-board and symbols with ballpoint pen; to make changes, peel off the symbol, rub out the flow lines, restick the symbol and draw new flow lines. A starter kit with 10 8½-by-14 base-boards and over 320 symbols is $8.95 plus $1.00 for postage and handling.

Fickled Thinking Aids, P.O. Box 6064, 980-m Enterprise St., Orange, CA 92667.

TAKE HOME A MICRO

Wintek has announced the Spring schedule for their workshop, "Hands-On Microprocessor Short Course With Free Take-Home Microcomputer." Attendees receive a microcomputer to use at the workshop and to take home when they leave. The computer has a 6800, RAM, PIA (parallel I/O), ACIA (serial I/O) and ROM with monitor. Course schedule is May 10-12, Lafayette, IN; May 24-26 Cleveland/Akron, OH; June 7-9, Syracuse, NY; June 21-23, Hackensack, NJ. Tuition is $495.

Wintek Corp., 902 N. 9th St., Lafayette, IN 47904. (371) 742-6802.



8080 OCTAL CODE CARD

Operating something like a slide rule, Tychon's 8080 Octal Code Card aids in programming and debugging 8080 software. It contains all the mnemonics and their corresponding octal codes, and all instructions are color-coded to indicate which flags are affected during execution. The pocket-sized card measures 6.5 by 3 inches, and on the back is an ASCII code chart for all 128 characters plus the 8080 status-word and register-pair codes. $2.98 postpaid.

Tychon, Inc., P.O. Box 242, Blacksburg, VA 24060.

"UP YOUR WORD" GAME

The game is played with 280 cardboard squares, 264 of them bearing English letters, 16 blank, to be cut from the four sheets supplied. Two or more persons play by mixing up the squares, dividing them up, and forming words on a letter put down by the first player. Blank letters stand for any letter a player chooses. The directions include five variations. $2 plus 30¢ postage in U.S., Canada, and Mexico, 50¢ elsewhere.

Popular Computing, Box 272, Calabasas, CA 91302.

WIRE-WRAPPING TOOLS

A line of wire-wrapping tools and accessories for the amateur electronics hobbyist has been developed by O.K. Machine and Tool Corp. The products include manual and battery-powered wire-wrapping tools, as well as precut and stripped wire, wire rolls, DIP sockets, and wire-wrapping kits designed for the individual enthusiast.

The 11-ounce BW-630 battery- operated tool, using C cells, is $34.95. For hand wrapping and unwrapping, the half-ounce WSU tool is $5.95.

O.K. Machine and Tool Corp., 3455 Conner St., Bronx, NY 10475.

STAR TREK

BASIC SUPER STAR TREK FOR ALTAIR 8800

BASIC Super Star Trek has features of Super Star Trek as found in "The Best of Creative Computing — Vol 1" but optimized to fit in an Altair 8800 with 16k total memory (including MITS 8K BASIC). Will run with other systems. High quality paper tape source is only $3.00. Includes 15 page description of game, program variables and routines. A MITS compatible tape cassette is also available for $6.00 to cover tape, copying, and handling costs — supplied on high-quality Maxwell UD tape.

D. C. Mitchell, 2S624 Mulberry Ct., Warrenville, Ill. 60555.

STAR TREK IN ALGOL

I have a Star Trek Game available in ALGOL for the Burroughs 6700/7700 systems running under CANDE. Because it uses the extremely powerful Burroughs ALGOL language, the game is very interesting to play (ex: each ship has its own data file). The price of $15.00 includes a 1500-line line printer listing and a paper tape.

Alex Begin, 7335 Deep Run, Apt. 523, Birmingham, Michigan, 48010.

STAR TREK FOR MITS ALTAIR 8800 SERIES

Several programs are available on paper tape and audio cassette. All versions will run on MITS 8K Basic interpreter. Some versions require only 16K of memory including the interpreter. These programs require less than 50% of the memory required by the original versions which are between 800 and 1800 lines of code. Most versions are $18.95 + $1.00 shipping and handling.

Send SASE for details to Mr. Charles P. Fischer, 355 South Creek Drive, Depew, New York 14043.

STAR TREK INFORMATION

No question about it, Star Trek really does live in the form of 250 local clubs, nearly 200 fan magazines, conventions across the country, books and many other sales items. The Star Trek Welcommittee has published "The Yellow Pages of Star Trek," a directory of clubs, zines, books, sale items, and conventions. Reasonably current, but some listings are bound to be out of date. 75¢.

Star Trek Welcommittee, Allyson Whitfield, P.O. Box 206, New Rochelle, NY 10804

CALCULATORS

CALCULATOR AS AID FOR MARINE NAVIGATION

Texas Instruments has introduced a library of 39 navigation programs for use with the handheld SR-52 magnetic-card-programmable calculator. Included are programs for celestial and coastal navigation, ocean sailing and sailboat racing tactics. A celestial fix can be obtained in two or three minutes. Racing sailors can determine optimum courses and tacking angles, and figure the times, courses and distances to reach the mark. An optional printer permits the calculator to be used as a learning tool by unskilled marine navigators. $299.95

Texas Instruments Inc., Inquiry Answering Service, P.O. Box 5012, M/S 308 (Attn: SR-52 NAVPAK), Dallas TX 75222.

COMPUTERIZED MATH DRILL

Part calculator and part computer, the Classmate 88 from Monroe uses an individualizes instruction approach to enable students to generate ulimited drill and practice routines in over 70 computational skills. Flowchart instructions allow students to work without supervision. All drill and practice programs are hardwired into the machine, with special keys to select the subject area. Automatic scoring permits the teacher to evaluate student progress.

Monroe, The American Road, Morris Plains, NJ 07950.

ROM MONITORS ARE GREAT ! ! !

They can transform a hobby computer into a professional, useful tool.

But why pay $300 for one? The MERLIN Video Interface is also a ROM Monitor board. The optional 2K x 8 MBI ROM Monitor/Editor is available for only $39.

The MERLIN Monitor provides commands for turnkey 8080 or Z80 operation and program debugging and the Editor is the best there is. Any BASIC or user program is compatible with the MBI software.

And now MiniTerm introduces the ROM/EROM kit so that you can put the rest of your operating system and general purpose routines in ROM for increased ease of use and reliability.

Just Look at these features:
☆ Power-on jump to any 1K block
☆ Holds eight 2708 EROMs
☆ Bank select feature
☆ S-100 bus compatible
☆ Wait state logic
☆ Addressable to any 4K block
And it's only $89 in kit form!

So write or buy your operating system — then optimize it for your specific needs and put it into ROM where it will always be available and yet changeable when necessary.

MiniTerm will also provide 2708s for $40 and will introduce its inexpensive 2708 programmer next month.

Once you've had or used a system with good ROM operating software (Monitor, Editor, Relocatable loader) you'll understand why ROM boards are becoming so popular.

But don't spend more for ROM boards with extra goodies when all you need is a board to hold your ROMs and to provide power-on jump. Buy the MiniTerm ROM/EAROM kit for only $89.

For more information fast, write direct.

MC and BAC accepted.

MiniTerm Associates, Inc.
Box 268, Bedford, Mass. 01730 (617) 648-1200

Creative Programming Techniques. . . .

A Crooked Shuffle

A Case Study in Bebugging The Programmer

Alan Filipski*

In an article on shuffling in the Jan.-Feb. 1977 issue of Creative Computing, John Jaworski considered the problem of generating the numbers from 1 to N in a random order without repetition (a "random permutation"). Both solutions given in that article have execution times on the order of N^2, *i.e.* shuffling 10N items would take about 100 times as long as shuffling N items for large N. My first reaction was that there is an obvious way to shuffle in linear time (time proportional to N for large N). It turns out that there is indeed such a way, but we have to be a little careful about what is "obvious." The following account traces the development of such an algorithm, pointing out some tempting fallacies along the way.

The germ of the idea is this: We first create an array containing the numbers from 1 to N in order. We then proceed to destroy that order by interchanging the contents of each location in turn with the contents of a location selected in some random fashion. To make this idea more precise, we could say

1. Generate an array A containing the numbers from 1 to N in order.

2. For each i from 1 to N:
Pick a random integer j between 1 and N and switch A_i with A_j.

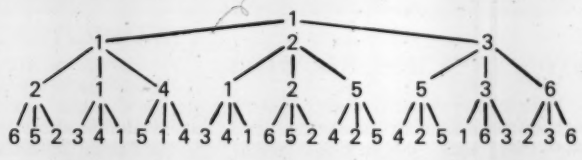
Thus every item gets switched at least once and on the average twice. This would be easy to program and takes linear time to execute. The method obviously mixes things up so thoroughly that we certainly must be getting random permutations. Of course, we could prove it if we wanted to, but proofs are just pedantic exercises, and besides, we have programming to do, right? Well, just for laughs, let's try to prove that this algorithm does what we want.

First, we should clarify exactly what we mean by the phrase "generating the numbers from 1 to N in a random order without repetition." The "without repetition" criterion is easy to verify because it is a property which must apply to *each* sequence generated. The "random order" criterion requires a little more thought, since it is a notion which applies to the entire class of permutations generated, but not to any single permutation (at least not without arousing some statistical and philosophical demons who are better left undisturbed). As a definition of "random order" we might venture to say that the probability of the number I appearing in the J^{th} position should be 1/N for all I and J between 1 and N. This insures that any number has an equal chance of appearing anywhere, so the program which satisfies this criterion must be generating all permutations at random, right? Wrong. Suppose N=3. Then the possible permutations are:

$P_1 = (1\ 2\ 3)$ $P_2 = (2\ 1\ 3)$ $P_3 = (3\ 2\ 1)$
$P_4 = (1\ 3\ 2)$ $P_5 = (2\ 3\ 1)$ $P_6 = (3\ 1\ 2)$

Consider a program which outputs P_1 or P_5 or P_6, each with probability 1/3. This satisfies our proposed criterion, but is obviously not what we mean by a random shuffle, because the probability of generaging P_2, P_3, or P_4 is zero. This suggests that what we really want to say is that our program must generate any permutation with equal probability (probability 1/n! in fact, since there are N! different permutations.) Now that we know what we want, let's see how our program goes about producing it.

Consider the case when N=3. The program starts with P_1. The first interchange transforms it to either P_1, P_2, or P_3 with probability 1/3 each. Two more interchanges are then performed on the result giving the final permutation. Since we have three choices at each of the stages, there is a total of 27 equally likely series of interchanges. Of course, some sequences of interchanges must produce the same result since only six different permutations are possible. We can represent these successive transformations by a tree as follows:



We note that at the final level, P_1, P_3, and P_6 occur four times each, while P_2, P_4, and P_5 occur five times each. The latter are therefore more likely to be generated than the former. Of course, if we were smart, we could have foreseen trouble just be observing that 6 does not divide 27 evenly.

So it appears that our algorithm does a rather slipshod shuffle. Well, what now? Is the idea bankrupt? Maybe noit. Consider

*Department of Mathematics, Central Michigan University, Mt. Pleasant, MI 48859.

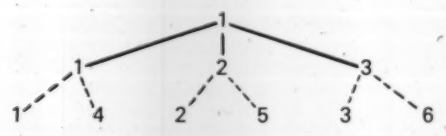
a modification of the technique: We start with the array A_1, A_2, A_3, . . . A_N containing the numbers from 1 through N in order. We begin as before by interchanging A_1 with the contents of a randomly selected location. We now want to set A_2 equal to one of the *remaining* items. This is the key to the rehabilitation of the algorithm. We accomplish this by selecting a random integer J between 2 and N and interchanging the contents of A_2 with A_J. Continuing in this way, our algorithm now becomes:

1. Generate an array A containing the numbers from 1 to N in order.

2. For each i from 1 to N: Pick a random integer j between i and N and switch A_i with A_j.

If we now display the situation for N = 3 in terms of our treee,

If we now display the situation for N = 3 in terms of our tree, we have:



which is exactly what we want, generating each permutation with probability 1/n!. We can now implement the algorithm with the following program:

```
100 DIM M(52)
110 LET N = 52
120 FOR I = 1 TO N
130 LET M(I) = I
140 NEXT I
150 FOR I = 1 TO N-1
160 LET J = INT(RND(0)*(N-I + 1)) + I
170 LET T = M(I)
180 LET M(I) = M(J)
190 LET M(J) = T
200 NEXT I
210 MAT PRINT M;
220 END
```

Thus we arrive at an efficient and simple solution to the original problem. As you may have guessed, however, the point of this paper is not the presentation of a shuffling algorithm which works in linear time (which can be found, for example, in Knuth's *Seminumerical Algorithms*) but rather an illustration of potential traps along the path of algorithm development. If you had (as I did) a tendency to swallow the argument that the first version of the algorithm "mixes things up so thoroughly that we must be getting random permutations," you have a bug in your quantitative intuition. This sort of bug is more insidious than any program bug since it potentially affects any algorithm you might develop. The existence of such bugs is not often publicized since it is ever the wont of mathematicians to display their creations in the austere beauty of their perfected form and to be ashamed of the false starts and jumpted conclusions along the way. (The exception here is the "paradox" which is such a dramatic and epidemic bug that it has entertainment value.)

If we are to make progress in exorcising these bugs, it behooves us to stop at least and recognize them for what they are. In the future, would we be more suspicious of a line like the "mix-em-up" argument? Is it clear that the picture of the tree leads to a proof in the case of the revised algorithm? Is it reasonable that N = 3 should yield a sufficiently general example to discredit the first algorithm, but that N = 2 should not? The consideration of such questions would be a first step in the debugging of the programmer. ●

Shuffling Revisited

The article on "Shuffling," in the Jan-Feb issue (page 77) drew a large response from readers who offered shorter or "more elegant" ways of solving the problem. Here are a few of the letters:

"More Elegant"

Dear Editor:

John Jaworski's article, "SHUFFLING", in the January-February issue contains a minor error in statement 180. The > symbol will produce a descending sort rather than the ascending sort shown in the before-and-after example. This has no real effect on the outcome except to reverse the order of the randomized integers.

Shown below are two routines which are more elegant than the shuffling technique (from the standpoint of requiring less iterations for a typical run and being more concise in code length):

The first uses a search technique borrowed from hashing algorithms rather than performing a sort.

```
100 DIM A(10), P(10)
110 FOR I = 1 TO 10
120 A(I) = I
130 NEXT I
```

A contains a table of integers, P will contain the integers in random sequence. The first loop puts the integers in A.

```
140 FOR I = 1 TO 10
150 J = INT (10*RND + 1)
160 IF A(J) > 0 THEN 210
170 J = J + 1
180 IF J < 11 THEN 160
190 J = 1
200 GO TO 160
```

Generate a random integer use this integer to access A Scan through A until you find an integer which has not been used yet.

```
210 P(I) = A(J)
220 A(J) = 0
230 NEXT I
```

Place the next integer in the output table and remove this integer from A

```
240 MAT PRINT P
250 END
```

Print P when all integers are moved.

The second routine shows how this same function appears in APL:

David D. Keefe
Tillson, NY

"Each Loop Used Only Once"

Dear Editor:

On reading "Shuffling" by Jaworski in Creative Programming Techniques, January-February 1977 issue, I notice a sort is required. For longer lists, this can be a time-consuming routine. Here is a routine to shuffle 52 cards in one pass. Cards are picked one at a time and each of the remaining cards has an equal chance of being picked.

```
100 DIM M(52)
110 N = 52
120 FOR I = 1 TO N
130 M(I) = I
140 NEXT I
```

Enter numbers 1 to N in list in order.

```
150 FOR I = 1 to N-1
160 R = (N + 1-I)*RND(1)
170 R = INT(R) + I
180 T = M(R)
190 M(R) = M(I)
200 M(I) = T
210 NEXT I
```

Pick number R between I and N.

Exchange entries I and R.

Each loop is used only once.

James Murphy
Associate Professor
California State College,
San Bernadino, CA 92407

"Simpler and Smaller"

Dear Editor:

The article by John Jaworski on "Shuffling" was very interesting. However, I am unimpressed by the little "moral" at the end. Several years ago I constructed a card-shuffling program based on an explanation of permutation theory based on a mail-clerk and pigeon holes. I don't remember the source of the explanation or its precise details, but I do remember the algorithm. Translated to BASIC it looks something like this:

```
DIM M(10)
FOR I = 1 TO 10          Initialize the array—this step
M(I) = I                 is only required once and the
NEXT I                   program can be used to
                         generate as many permuta-
                         tions as you wish.

FOR J = 1 to 9
K = M(J)
L = INT ((11-J)*RND + 1)
M(J) = M(L + J - 1)
M(L) = K
NEXT J
```

As you can see, the algorithm chooses each element of the permutation randomly from the numbers not previously chosen. The advantages over sorting are: (1) less memory is required (only one vector instead of 2), (2) fewer exchanges per permutation (no sorting program can beat N – 1 consistently), (3) no comparisons at all and (4) the program itself is much simpler and smaller.

The January February issue was my first experience of your magazine—I enjoyed it thoroughly! Keep on computing!

Dean Ritchie
Systems Programming Manager
Computing Center
Washington State University
Pullman, WA 99163

"Requires Less Memory and Time"

Dear Editor:

This letter could be headed "A Better Way to Shuffle." I was disappointed to see that John Jaworski omitted one easy shuffling technique—random indexing—from his treatment of BASIC programming, and wish to fill the void. To shuffle an array using random indexing is to choose elements by using random numbers to calculate addresses. The following BASIC statement will calculate the address of one of an N-element array with subscripts ranging from 1 to N. If your BASIC interpreter recognizes the zeroth element of an array, then the statement will have to be changed to avoid wasting an array element.

```
I = INT(N*RND(0) + 1)
```

After the Ith element is removed from the array and stored in a safe location, the array is packed by moving the top elements down one space, and N is decremented by 1. Another element is selected using the same method, and the process repeated until the array is used up. You might think two large arrays would be needed, one to hold the source array of elements, and one to hold the shuffled array, but that isn't so. Remember that after the Ith element was selected, the remaining elements were packed together to eliminate the gap. That left a gap at the top of the array where the element would fit nicely. Packing the array isn't difficult, either. Because the shuffled array is supposed to be in random sequence, it really doesn't matter what order the source array is in. To pack the array, remove the unselected upper element from the top of the array and plug the gap. Putting it all together for a program to print nine digit numbers, with no two digits the same, yields the following BASIC code:

```
 100 DIM A(9)
 200 REM FILL THE ARRAY WITH
 300 REM THE DIGITS FROM 1
 400 REM TO 9
 500 FOR I = 1 TO 9
 600 LET A(I) = I
 700 NEXT I
 800 REM THE SHUFFLING ROUTINE
 900 FOR I = 9 TO 2 STEP -1
1000 LET J = INT(I*RND(0) + 1)
1100 IF J>I THEN 1000
1200 LET T = A(J)
1300 LET A(J) = A(I)
1400 LET A(I) = T
1500 NEXT I
1600 FOR I = 1 TO 9
1700 PRINT A(I)
1800 NEXT I
1900 END
```

This program requires less memory and time than the routines provided by Mr. Jaworski. Speed and space-saving are important, especially in a program like BLACKJACK which shuffles a 52-card deck several times.

William R. Hamblen
946 Evans Rd.
Nashville, TN 37204

"At Random"

Dear Editor:

While looking through the January/February *Creative Computing*, I noticed the "Shuffling" article (J. Jaworski, p.77), thought, "There, but for the grace of Iverson, goes 10?10," and turned the page. But then, upon a closer reading of the magazine, I discovered the same technique advocated on the very facing page! And with the same ineluctable bubble sort! This was too much. Even with a good sort, the program is inefficient. The obvious way to shuffle 10 or any number of n numbers is: a) pick one at random b) pick one of those remaining c) continue until none are left. Since the two sets, picked and unpicked, will always total 10 (or however many) numbers, we just move the boundary through the array, exchanging the number whose place we want with the one we wish to put there. BASICly:

```
100 DIM A(10)                          A is 1, 2, . . . ,10.
110 FOR I = 1 TO 10
120 A(I) = I
130 NEXT I
140 FOR I = 1 TO 9                     I is the boundary.
150 K = I + INT (RND*[11-I])           K is a random number
160 T = A(I)                           from I to 10.
170 A(I) = A(K)                        Exchange
180 A(K) = T
190 NEXT I
200 MAT PRINT A;                       Done.
210 END
```

Using the sorting method squares the time (depending on the sort) and doubles the space (code and arrays) that the program requires.

J. Storrs Hall
New Brunswick, NJ

"Faster"

Dear Editor:

I read the article in January/February *Creative Computing* on Shuffling numbers.

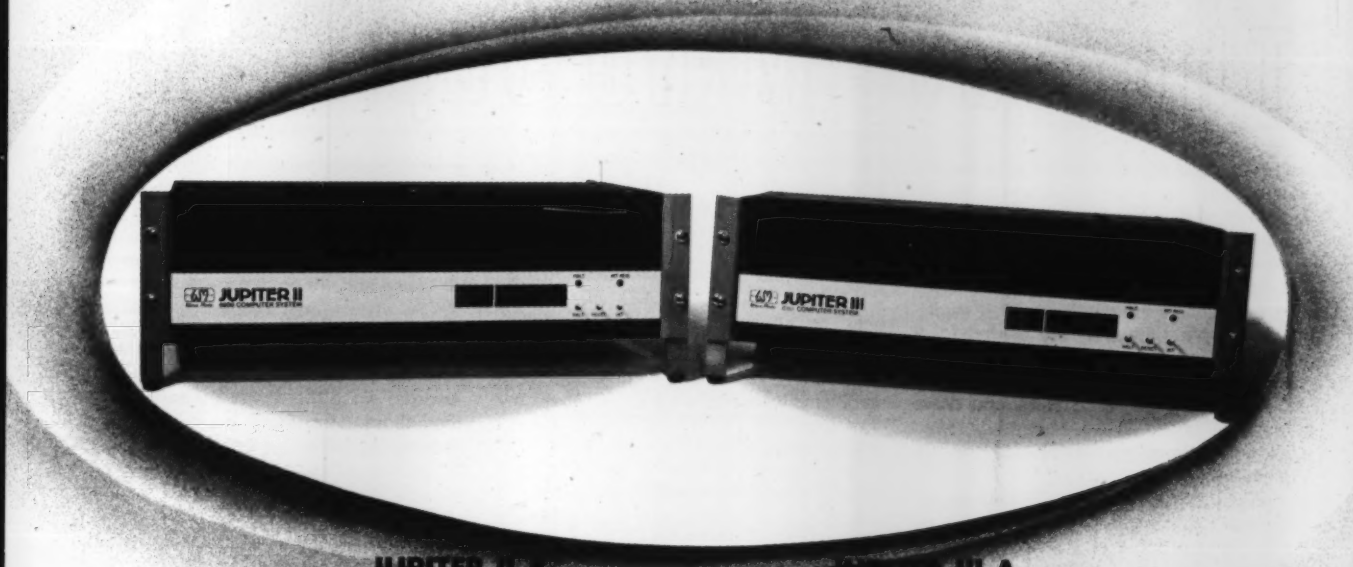
I have a program which also shuffles numbers, which is simpler to program and executes faster than the program in the article.

I want to share it with your readers.

```
10 RANDOMIZE
100 DIM A(10, P(10)
110 FOR I = 1 TO 10
120 LET A(I) = I
130 NEXT I
140 FOR I = 1 TO 10
150 LET T = INT((11-I)*RND) + 1
160 LET P(I) = A(T)
170 LET A(T) = A(11-I)
180NEXT I
190 MAT PRINT P;
200 END
```

Elliott Werner
ARCDATA Systems
66-51 Booth Street
Rego Park, NY 11374

POPULARITY EXPLOSION!



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A Creative Computing Equipment Profile . . . .

The Wave Mate Jupiter II

Dr. Mark Boyd*

Last Spring I was in the market for a complete microcomputer in kit form. After obtaining literature from four companies (Altair, IMSAI, Sphere, and Wave Mate), I chose Wave Mate. It offered everything from one source, with the emphasis on quality.

My system (the Jupiter IIC with an additional 8K of memory and a serial interface) was ordered in late May. Delivery began in August, but the final pieces did not arrive until early October. Much of this delay was due to documentation problems (the construction manuals weren't ready).

Building the Jupiter II:

Wave Mate supplied high quality tools with the kit, everything needed except a soldering iron and a pair of diagonal cutters. The power supply and keyboard, which would require considerable soldering, were supplied assembled and tested.

Each board kit was packed with its components organized by assembly sequence. Missing parts were listed on a note in each kit. There was only one packing error in all my kits—very good for a project of this size.

Assembly was easy, if a bit tedious. The parts were all of high quality and the instructions were clear, so no unexpected problems were encountered. This was my first experience with wire-wrapping, but I found it easy to learn.

Wire-wrapping from a list of to-from codes is a mind-numbing experience. I could only wrap for about two hours at a stretch. Since it took around sixty hours of wrapping to finish all my boards, I worked on them over a period of close to a month.

After wrapping each board, I checked for incorrect or missing wraps by using a chain list. This is a list of pins that should be connected together by the wire wrapping. A simple continuity test verified my wrapping; missed or incorrect wraps were fixed as I went through the list.

Wave Mate supplies wire probes to use for the continuity test, but the user must supply an ohm meter or other indicator. They recommend checking from the top of the board, but I found it easier to work from the wire-wrapped side. I used an audible alert device, powered by a flashlight battery, as a continuity tester.

I think the assembly process is less error-prone than soldering an equally complex circuit on PC boards. My biggest worry was the possibility of extra wires on the boards, since there was no easy way to find them. This worry, as it turned out, was quite justified, as I found when I tried to get my computer to work.

Debugging:

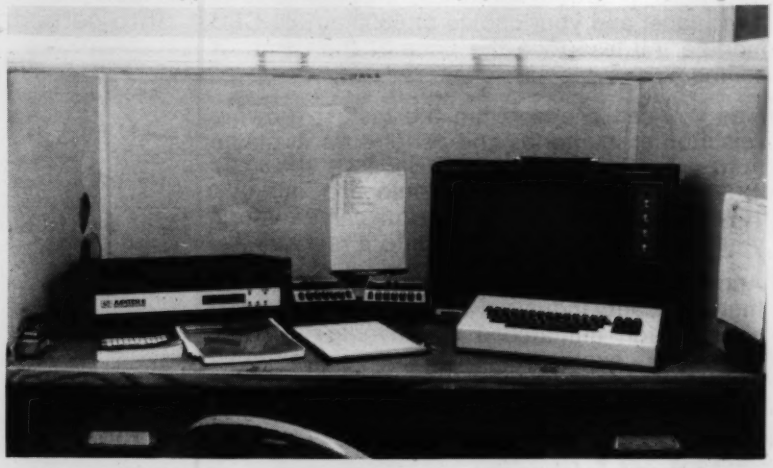
Even after double checking all the boards, my computer wouldn't come up properly. My efforts to find the problem were hampered by not having the schematics for most of the boards. Finally, after talking to Dennis Brown a couple of times on the phone, I sent all the boards back for them to check.

They were back in not much over a week, with a repair and checkout bill for $50.00. I still had a problem, but it turned out to be a capacitor which was knocked loose in shipping. The original problem was an extra wire on the CPU board. Dennis subsequently indicated that he will try to provide a check list for the correct number of wraps on each pin with future kits. This would make it easier to find extra wires.

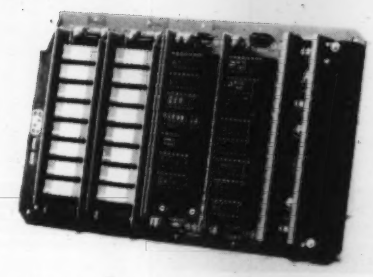
My system was up and running in mid-

Editor's note. . . . Although Mark Boyd sent a photo of his system with this review I thought it would be helpful to include pictures of the wire wrapped boards and called Dennis Brown at Wave Mate to ask if he would or could send me some. As Mark says in this article, he was very pleasant to deal with and cooperative. He also found it ironical that it should have been Mark Boyd who reviewed the Jupiter II. As he wrote in the letter he sent me with the photos, "In checking our records, we have found only two machines returned for repairs. Dr. Mark Boyd returned his system. One wiring error was found and corrected. The U.S. Forest Service, Bishop, California, returned their system; the problem turned out to be software, not hardware."

*St. Mary of the Plains College, Dodge City, Kansas 67801



Mark Boyd's system



Front (top) view: 8K Dynamic Memory Module

November. It has been working reliably ever since. The only hardware problems I've had are: a weak driver transistor in one cassette motor control, no sync when I invert the display (white on black), and an interlace problem on the first line of the display.

Using the Jupiter II:

The monitor program comes on when the system is powered up (I can't say turned on because it has no on/off switch). This program resides in 3K of EPROM, starting at F000. It offers a good range of control functions: 4 console display modes, read, write, search, and transfer commands, single step program execution, multiple breakpoints, MIKBUG I/O, and simple I/O commands for use in user programs.

One of the display modes is for opcodes. This is very handy for machine language programming and debugging. Other modes include: single byte hex, double byte hex, and single byte ASCII. Keyboard entry is in either ASCII or hex.

The user I/O commands are 3Fxx type machine codes (3F is the 6800 software interrupt command). 3F00 is the program abort code; it returns control to the monitor and displays the address where the abort occurred. Other 3Fxx codes allow input or output of ASCII or hex. I was able to duplicate all the MIKBUG I/O routines with simple subroutines using 3Fxx codes. This means I can run a lot of available software with only minor revisions.

The text editor is an extremely versatile program. It allows you to create, edit, store, and retrieve ASCII files. It also allows two byte decimal arithmetic and logical operations. The results of these operations may be used to condition other operations, and macro commands may be constructed from a series of single commands entered on one line. The power of these macro commands is truly impressive.

The only improvement that I would like to see in this program is a way to easily edit text containing lower case letters. As it stands now you can input and output files containing both upper and lower case letters, but you can't edit them.

The assembler is an extended version of Motorola's two pass assembler. This version offers more flexibility in label names and operand fields than the original. Normally it is used with a source tape prepared by the text editor, but it can also be used as a one pass assembler from the keyboard. The outputs are a MIKBUG formatted binary and an assembler listing to separately determined devices.

The BASIC software includes Wave Mate's "Byte String BASIC" and SWTPC's 4K BASIC (with a patch list of required modifications). The documentation on these programs, which I received in Jan. '77, is somewhat better than the earlier text editor and assembler documentation.

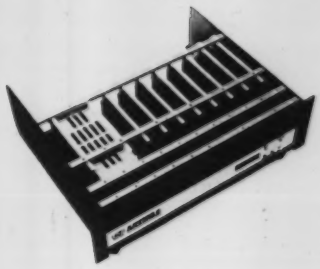
The Byte String BASIC has only one byte (0-255,0) arithmetic, but can directly address memory and call an unlimited number of machine subroutines. This BASIC has almost all the commands of Dartmouth BASIC, plus CALL (for machine language subroutines) and IF:THEN:ELSE. The string variables start with a length byte, and can be up to 255 bytes long. While there are no specific string operations, variable subscripts on the strings allow programming of sophisticated string manipulations.

SWTPC's 4K BASIC is easy to modify for the Jupiter II; only about 60 machine language instructions must be changed or added. Unfortunately, my patch list (a list of the required changes) had a typing error. As a result the modified program self-destructed when I tried to run it. I found the rror (after several hours of frustration) and I'm sure it will be corrected in future patch lists.

Documentation:

The only serious problem I've found with the Jupiter II system is lack of documentation. They have not supplied adequate manuals on anything other than the CPU board. I have preliminary manuals (very sketchy, missing figures, etc.) on the other boards.

The software documentation consists of a list of commands and a brief description of what they do. Sometimes examples are given, but no actual listings to show how they are used. I had to phone Wave Mate to learn how to use the text editor and assembler. This is an unnecessary waste of everybody's time and money.



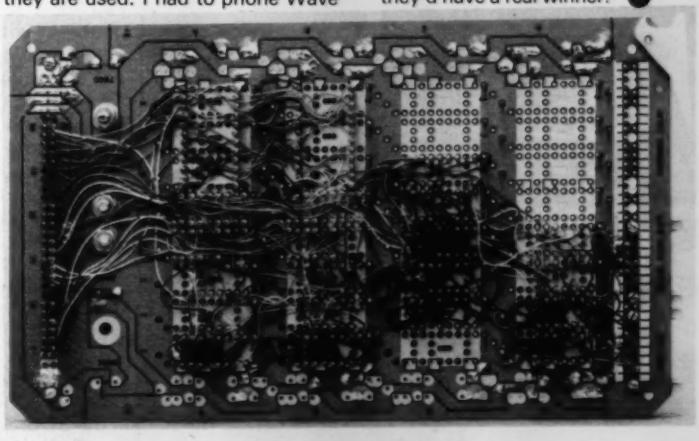
Top view of Jupiter card cage, without screen

The software documentation does not include assembler listings, or any information on how the software is coded. I have a few minor bugs in both the text editor and the assembler which would probably be simple to fix if I had assembler listings.

Conclusion:

As you can tell by the general tone of this article, I like the Jupiter II system. It is well designed and the design is executed with high quality components. I also like Dennis Brown and Alison Martin. They have always been friendly and helpful, if a little vague as to when the software and documentation would be ready. I think thy've put off the drudge work of documentation in favor of other, more interesting, things.

At the present time, this is a good system for people with good software backgrounds. A hardware background isn't necessary to successfully assembe it from a kit since the instructions are clear in that dimension. One of its real virtues is its hardware flexibility. Because of its wire-wrap construction and universal wire wrap boards, this system can't be outdated by new developments in microcomputer technology which are bound to occur. If someone could now figure out how to prevent software and documentation from becoming outdated in a few months, they'd have a real winner! ●



Rear view: Dual Serial Interface

The Sol-20: Simple Enough For a Six-Year Old

by Steve North

One of the most obvious trends in personal computing is toward the "complete" computer kit — one which contains all or most of the ingredients of a usable computer system. Increasingly, units are being offered assembled too. The "complete" unit not only makes putting together a system easier (since the buyer need only select a single package, rather than a mainframe from one manufacturer, memory from another, etc.) but also makes the use of a system easier since it often features a monitor on PROM. An outstanding (but by no means the only) example of this kind of computer is Processor Technology's SOL System.

The foundation of the SOL ps a single large PC board containing:

- An 8080-based CPU. Let's not dredge up all the old 8080 vs. other MPU's argument; suffice to say that the 8080 *is* one of the most popular MPU's in amateur computing and there is a large body of support software for it (not to mention some interesting hardware).
- A Personality Module. That's PTCO's fancy name for a small (1½" x 3") PROM card which plugs into the SOL, containing a hex monitor. Having a monitor on PROM eliminates the need for an expensive and sometimes unneededfront panel. The PROM card is not designed for the S-100 bus, hence it keeps the price of the system down while maintaining a level of flexibility which would be lost were the PROM built into the main PC board.

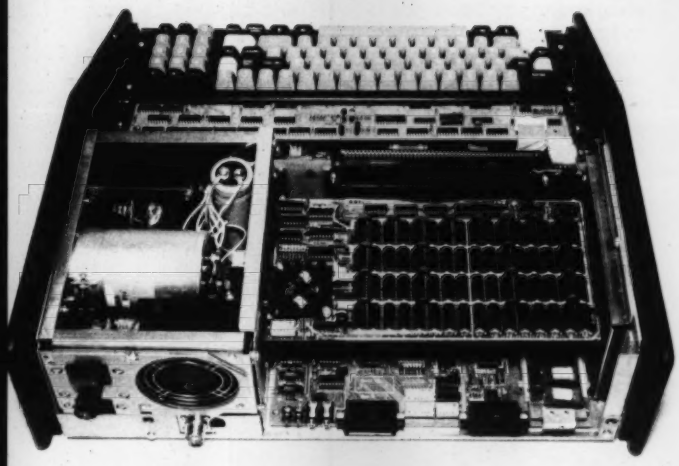
Sol-20 with covers removed. Front (or keyboard) is in foreground, power supply is in right rear corner, expansion chassis (with 8KRA Memory installed) is to left of power supply. The vertical board just behind white connector on left is the backplane board.

- 1K RAM, intended primarily as scratch pad for the Personality Module.
- The equivalent of a Processor Technology VDM-1. For those of you not familiar with amateur computing hardware, a VDM (Video Display Module) is a high speed video driver, which, with the proper software, can be made to simulate a fancy CRT. If you don't need hard copy, it's all you need for humanreadable output. You will need a TV to connect to it. Output for a video monitor or modified TV is provided, however, it is a simple enough job to mount a Pixeverter inside the SOL for direct RF entry into a TV set.
- A parallel and a serial data port. These permit you to use peripherals such as Teletypes or optical papertape readers with your SOL without buying separate interface boards.
- Two cassette interfaces with motor control. They operate with both the Byte/Kansas City Standard, and PT's new 1200 baud standard (ever wonder why they're called standards anymore?). Sophisticated use of cassettes for mass storage in the future will no doubt require computer control of the cassette motor and perhaps two tape units — at least.

The SOL also includes an 80-key keyboard with the full ASCII character set, as well as special function keys such as SHIFT LOCK, UPPER CASE, LOCAL, MODE SELECT, et al. The SOL power supply seems adequate for the job. There are also five S-100 compatible slots in the SOL. Offhand that doesn't seem like a lot, because most of your memory has to go here. Still, five 8K RAMs gives you 40K of memory which is more than most people have. Processor Tech is already marketing a 16K RAM board, and you can be sure a 64K RAM board isn't too far away. If you plan major expansion of your computer, remember that a floppy disc interface, TV Dazzler, and music-making module would only leave one slot in the SOL for memory. That's the price you pay for compactness. But if you don't plan to make your computer a continuing investment or put every application in the book on it, the SOL should be all you need. The entire unit is housed in a nice-looking cabinet with walnut sides, about the size of a portable electric typewriter.

We'll leave details on building the SOL to other hardware-oriented magazines. However, construction of the SOL looked fairly typical for a computer kit. It did seem that there were a lot of "Engineering Modifications" because of errors or updates in PC design, requiring cutting of traces and running jumper wires. Of course, it would be logical to expect Processor Tech to revise the boards so future buyers may not have this problem.

When the SOL is turned on, the program in the Personality Module initializes the system and enters the *terminal mode*. In this mode, what is typed on the keyboard is sent to the serial port and data received at the serial port is displayed by the Personality Module Software via the VDM to your TV set. The I/O at the serial port is either half or full duplex, selected by a switch inside the SOL. So for the price of a SOL (and a TV set) you have a nifty little terminal.



Sol-20 with covers removed. Rear side of assembly is in foreground and Sol-PC is just visible at lower right rear of assembly. 8KRA Memory is installed in expansion chassis above Sol-PC.

But SOL is also a *stand-alone computer.* Hit mode-select, and you're running the hex monitor located on the Personality Module. Three versions are available — CONSOL, SOLED, and SOLOS. CONSOL, the simplest, permits you to enter and dump memory in hex, execute a user program, return to terminal mode, or to load a program from cassette tape. The BA (for BASIC) command executes a user program at 0000. This suggests that a person could just turn on the SOL, hit mode-select, type TL to load BASIC, then type BASIC and go, without knowing anything about machine code.

Indeed, with SOLOS, one has only to type TXEQ BASIC/1, and you're off and running (see box). SOLOS provides more sophisticated I/O handling and tape cassette commands than CONSOL, while SOLED is designed for advanced editing features.

These monitors permit dynamic assignment of the input and output devices to be used. Thus, user programs can use the monitor for their I/O operations and you can change I/O devices without patching the program. The default devices are the keyboard for input and VDM for output. Most of our experience has been with the SOLOS monitor which we've found exceptionally easy to use. More important, it's had the flexibility to do virtually anything we wanted.

One thing we liked about the CUTS (Computer Users Tape System) cassette was that Processor Tech has standardized the format of the data to be used on their object tapes as well as the actual means used to record it. The format includes a header label with information on the name of the file, executing address, and length. That may not seem like a big deal, but if your system merely saves one huge block of data on a tape and then a checksum (a la Tarbell and others), it is impossible to search for a particular file, or even find out what a file is. On the other hand, once people are using a simple (standard?) format for exchanging data it's difficult to get them to change. Also, it takes more software to process sophisticated data formats and nobody we know likes to toggle in long tape handling routines, however, if you have a nice SOLOS monitor in PROM, who cares?

I guess what we're saying is that the SOLOS monitor and CUTS cassette system is great for saving and retrieving programs for your own use. However, this combination is not likely to be adopted as an industry standard, hence you'll probably be limited to exchanging programs with other SOL users. In most cases, this is probably not a disadvantage, but just a factor to be considered.

Processor Tech supplies an expanded version of their 5K BASIC with the SOL. It is a fairly typical BASIC — floating point math, one-dimensional arrays, multiple statements per line, etc. One very handy feature — it permits writing and reading data from a CUTS cassette. Unfortunately, 5K BASIC seems a bit klugy and sometimes limiting. For instance, to prematurely exit a FOR/NEXT/loop, you must set a switch and finish the loop, *then* branch. There have been complaints about formatted PRINT statements not working properly. In our own rather extensive use of 5K BASIC in the past few months we've found rather unexpected ways to restart the interpreter with an arithmetic expression, and to crash the interpreter with an undimensioned array or with a peculiar FOR/NEXT loop combination. Granted, this is abuse of the interpreter but it was found accidentally, not intentionally, and it must be expected that other people will do the same.

Despite the minor criticism of 5K BASIC, the system is eminently useful. A number of CAI programs (described elsewhere in this issue) were written on the system. But perhaps the best testimony comes from 3 children, ages 6, 7, and 8 who simply follow a set of instructions (see box) *completely on their own* to run their programs. It's difficult to find another system — mini, micro, or timesharing terminal — that's this easy and straightforward to use. ●

Complete start up and shut down instructions for a Sol 20. The system is used regularly by 6,7, and 8 year old children for math drill and practice.

STARTING UP

1. Turn on computer and TV set, upper case should be lit
2. Plug in cassette recorder
3. If tape is not rewound,
   A. Press "REW" on recorder
   B. Type TC↵ (↵ =Return Key)
   C. When tape is rewound, press "MODE SELECT"

   Tape Counter
4. Press "PLAY" on recorder
5. Type TXEQ BASIC/1↵ 0-25
   Screen should say: Sol BASIC-5
   READY
6. Type XEQ-CAI↵ 25-28
   (Addition drill and practice)
7. Press "MODE SELECT" To exit program

6a. Type XEQ-MULTI↵ 28-32
   (Multiplication and division)
7a. Press "MODE SELECT" to exit

6b. Type XEQ-GUESS↵ 32-35
   (Guessing game)
7b. Press "MODE SELECT" to exit

To restart a program, Type "RUN" key
To clear an error, Type "DEL" key

SHUTTING DOWN

1. Press "STOP" on recorder
2. Turn off computer and TV set
3. Unplug recorder

Sophisticated Electronic Pocket Calculators: Theory and Practice for the Consumer and User

Edward R. Tufte*

Here are nine principles to help the consumer and user of sophisticated pocket calculators. These principles are general, applying to most all calculators (at least those that have a reasonable number of keyboard operations—say 40 or more).

I have no personal interest, direct or indirect, in any of the calculators or their parent companies discussed here. Among the calculators I have purchased, three were pretty good and two were lemons. Among those borrowed, the good-to-lemon ration has also run about 3 to 2. At any rate, this review is an independent personal evaluation, reflecting solely my experiences and prejudices.

GENERAL PRINCIPLE 1: *The half-life of calculator prices is about 18 months.* In other words, today's price will be cut by at least 50% within the next 18 months. The Texas Instruments SR-51, for example, was advertised at $224.95 in the March, 1975 issue of *Scientific American.* In February, 1977 the same machine sells for $65 at discount shops. General Principle 1 has several consequences:

Don't buy a calculator when it first comes on the market, unless you really like it. Consider if you had bought the SR-51 at $225 two years ago. Since it is now selling at $65, you would have paid $160 to rent that machine for two years plus have to forego other uses of the $225 for the whole period.

Buy at a discount. There is a lively, fast-moving market in calculators and the short half-life of prices encourages big discounts. Discounts of a minimum of 20% from the list price are available. The nominal price given by the manufacturer in the glossy advertisements is pretty much fantasy. By the way, the guarantee on the calculator is with the *manufacturer* and so there are no advantages to local servicing because there is no local servicing (Sam's Camera and Calculator Shop can't fix an HP-65 programmable, magnetic-strip read/write calculator).

GENERAL PRINCIPLE 2: *The breakdown rate of pocket electronic calculators is too high.* What evidence I have indicates that substantial numbers of calculators die within the first year of operation—perhaps one-third of all machines. There is too much of a throw-away mentality prevailing in the industry. Hewlett-Packard has the best reputation for reliable calculators (which may account for their relatively high cost).

GENERAL PRINCIPLE 3: *Calculators will continue to improve at the rate of the past few years.* A new generation has passed about every six years in the development of computational devices. On average, each new generation has increased speed by tenfold, memory capacity twentyfold, decreased component cost tenfold, and system cost at least two fold. Rapid progress continues. Now 16,000 bits of binary storage are available on a 1/32-inch square—just what you've always wanted. The rate of improvement means that today's machine will be replaced by something twice as good at half the price next year. It also means that calculators should be rapidly depreciated on your income tax.

GENERAL PRINCIPLE 4: *Computational technology has completely overrun input-output technology.* The great limits on calculators for any sort of serious work are the inability to monitor past inputs, and the single read-out register. We have a 19th-century printing technology that cannot cope with a 21st-century computational technology.

*Edward R. Tufte is Professor of Public Affairs at Princeton University. His books include *Data Analysis for Politics and Policy* and *Elections and Economics.*

GENERAL PRINCIPLE 5: *Printing is worth it.* The great tragedy of the HP-65, and $800 programmable wonder-machine, is that it shows you only one number at a time, often only one time. For what most of us do with calculators, we want to see a lot of numbers a lot of times. Printing, even though expensive, is worth it. I would buy a much less computationally fancy machine in order to have one of those little Mickey Mouse printers now available.

The philosophy behind most calculators today is one that was commonly found in computer centers some years back: the point of the machine is to do lots of fancy computing in order to come up with an answer consisting of a single number. Such doctrine, however is not consistent with the development of good home calculating.

GENERAL PRINCIPLE 6: *Sophisticated pocket calculators, particularly the programmable kind, are like those phonograph records that purport to teach foreign languages (Learn Swedish in 8 Hours); that is, they are purchased with all kinds of good intentions to really make use of them and change one's life, they are used once or twice, and then they sit on the shelf months on end just making one feel guilty.* Programmable calculators with 224 steps and read/write options are nifty but expensive; make sure there is at least one chance in ten that you will use the programmable part of the package after you buy such a machine. Machines that print, rather than those that are programmable, are much more likely to be useful. (Programmable calculators can even cram into their little memories a multiple regression program for three variables. Terribly ingenious, but not useful for any serious analysis, it is like Dr. Samuel Johnson's dog that could walk on its hind legs: "It is not done well, but you are surprised to find it done at all.")

GENERAL PRINCIPLE 7: *Instruction manuals vary tremendously in quality; and they usually have errors in them.* Sometimes instruction manuals for calculators appear to have been written originally in some language other than English—and both the author and translator had something more important to do that day than produce the manual. Hewlett-Packard manuals are easily the best; those from Texas Instruments are pretty good, but uneven; and manuals from other companies are a real risk. I recommend looking at the instruction manual before buying any brand except HP and TI.

GENERAL PRINCIPLE 8: *Calculators are designed by engineers and business people for engineers and business people.* Calculator manufacturers believe that their market is found among people in business and engineering. Machines are not designed to handle problems of data analysis and simple statistical work; data files are hard to manage; statistical manipulations are hard to perform.

GENERAL PRINCIPLE 9: *By any sort of long-term perspective, the small sophisticated electronic pocket calculator is a miracle.* No telling what is good for, but it is still a miracle. For a few hundred dollars, I have as much computational power on my desk now as there was in most major university computing centers 15 or 20 years ago. If I only knew what to do with it. ●

ANALYSIS AND DESIGN OF DIGITAL CIRCUITS AND COMPUTER SYSTEMS

Paul W. Chirlian

This is an introductory book in Digital Circuits and Systems. It not only provides the reader with the basic ideas of switching theory, but also provides him with an understanding of the total operation of the complete computer system. The topics of digital electronics and computer interfacing are also considered. The ideas discussed here also provide the basic understanding of microprocessors and minicomputers.

PROGRAMMABLE CALCULATORS

Charles J. Sippl

Written at an understandable level, this handy reference is designed for anyone interested in calculators. This is a pragmatic "how to use what's available" book on a difficult-to-understand subject. This reference offers a 16 page appendix of glossary terms as well as an appendix of clearly-defined capabilities of products available in the market place. A complete guide to the industry as well as a tutorial book.

FUNDAMENTAL PRINCIPLES OF MICROCOMPUTER ARCHITECTURE

Keith L. Doty

This book provides a complete basis for exploring the dynamic field of microcomputer systems and applications. After a general overview of the microcomputer scene, the author illustrates how general computation is a form of accounting with a decision-making capability. After developing confidence in the power of these existing devices, he proceeds to develop the notion of information and its representation as is seen by the computer and the programmer. No prior programming knowledge is assumed and elementary material on programming is presented.

2^{10} QUESTIONS AND ANSWERS ABOUT HOME COMPUTERS

Richard L. Didday

A book for the person interested in microcomputers who wants to get an idea of what it can be like before buying the equipment and for the person with a microcomputer who wants ideas for things to do, help in reading the literature, help in deciding what ways to go.

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Coin-in-the-Slot Computing at a Public Library

Harold M. Shair *

The public library, a fixture in every community, is a natural location for public-access computing. The concept that a public library is a place where you only take out books has gone the way of the Stanley Steamer. If your library doesn't loan out records and artwork, if it doesn't hold field trips and events, then it's time to throw out the library board. In fact, the modern public library can be thought of as a complete community information and activities center.

At a community information center, it's only natural that public-access computing be available. In a public library, the computer should not have any restrictions on its use. If it's to be used for fun, so be it; if it's to be used for business, that's all right too. Programs of general interest should be made available for people who know nothing about computers. Storage facilities or media should be available for those who wish to write their own personal programs or store their own data. Courses on computer applications and programming should be offered, and events such as contests and fairs should be held.

The first installation to try to achieve these aims is at the White Plains Public Library, in Westchester County, near New York City. In order to place a computer in a public library, several unique conditions had to be met:

1. It had to be installed as a concession, since the capitol budget of the library couldn't stand the cost of an outright purchase.
2. A fee for use had to be charged, not only to pay for the installation, if possible, but even if the money were not needed, to engender respect for the value of the service and equipment.
3. The computer had to be as self-service as possible, since it could demand only minimal support from the library staff.

The computer used in this installation is a Wang 2200B minicomputer with 8K of user memory available. The Wang was chosen because it has a permanent BASIC interpreter and operating system in ROM, a non-menacing typewriter-like keyboard and a 12-inch (diagonal) CRT. Their users group, called "SWAP," was also available as a source of programs in several categories. The programs are stored on cassette tapes, which are kept at the reference desk. Also available at the reference desk is the complete set of reference and programming manuals.

In order to charge for its use as well as provide for the minimal support from the reference staff, the computer is coin-operated. The coin box is a timer, similar to those found in coin laundries, which interrupts the CRT line to blank the screen of the CRT when the time is up. When more coins are inserted, everything is restored as it was. The charge is presently 25 cents for 4¼ minutes ($3.50 per hour).

To use the computer for the first time, a patron has to follow instructions on a wall chart above the computer. At a certain point, the CRT takes over and the programs provide their own operating instructions. The collection of software consists of games and demonstrations, personal finance, educational demonstrations, mathematics, statistics, finance and engineering. The list of programs available (below) is as provided for library patrons. As expected, the most popular use of the computer is game-playing. Bowling tournaments have been held and trophys awarded, a library first. In addition, an ongoing Startrek competition is on cassette. One un-

*Consultant to the White Plains Public Library

Wang 2200B minicomputer at White Plains Public Library, with coin-box timer at left.

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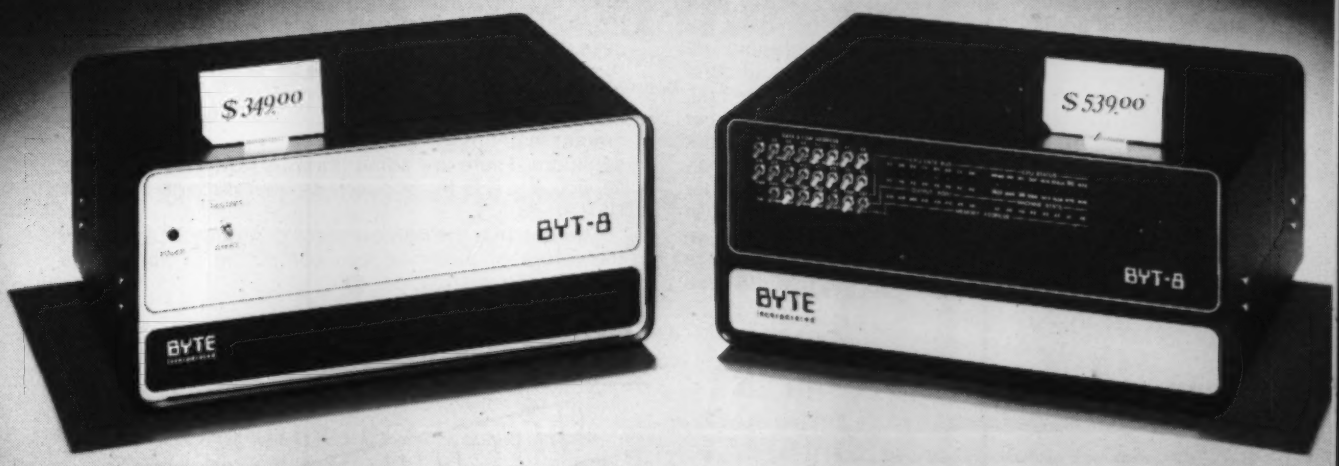

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usual program, which unfortunately was banned, would have helped improvers of the breed massage statistics derived from the pages of the *Daily Racing Form* as an aid to investment decisions. The library would not let that program be offered even though the basis of the program came from a book borrowed from the library.

The future for community computers in public libraries is cloudy. Public institutions are lucky these days to maintain what they have and can hardly be expected to invest in "way-out" ideas. The average library director is not familiar with computers and perhaps is a bit afraid of them. A concession would overcome these problems but revenues from use alone are at present insufficient to make it profitable. Additional revenue from courses and seminars would help, as well as add to the pool of users of the system. One service that is feasible, but has not been implemented due to lack of time and money, is self-service retail information-bank access. Information banks are vast bibliographic resources on disks. The two most relevant to general public use are Lockheed's "Dialog," with technical, educational, psychological, business and many other bibliographical abstracts. The other is the New York Times Information Bank with access to 25 million articles from *New York Times* and dozens of other publications. Another service that would be useful in the White Plains Library would be "Lexis," the legal information bank, since the library shares the same plaza as the county and state courthouse. The use of these

The public library, a fixture in every community, is a natural location for public-access computing.

data banks, however, can run from $50 to $200 per hour on a retail basis, with the average search taking 15 minutes. Those fifteen minutes might replace a week or more of catalog work. Many businesses and universities subscribe to these services, using a terminal for access.

This service could be offered on a self-service basis with local credit-card billing. The library computer would check the credit of the patron and initiate the call to the information bank using an automatic dialing unit. It would perform the necessary handshakes, preprocess data and keep tabs on the customer's bill (even to the point of signing off automatically when a preset time and/or money limit is reached). Training on how to use particular data banks could be provided by programs that "play" information bank, as well as by seminars. There are some libraries now that offer this service, but it is tax-supported either through library or NSF funds.

The role that the new personal computers can play in the future of public-access computing in libraries is also under investigation. ●

LIST OF COMPUT-O-MAT PROGRAMS

INTRODUCTION TO COMPUTERS -- Recommended for library patrons who are not familiar with the Comput-O-Mat.

GAMES -- This side of the cassette contains 7 game programs:
1 Horse Race
2 Craps
3 One-armed Bandit
4 Tic-Tac-Toe
5 Blackjack
6 Bowling
7 Football

BRAIN GAMES -- This side of the GAMES cassette contains 5 more advanced game programs:
1 Cryptograms
2 Submarine Commander
3 Arithmetic Quiz
* 4 Stock Market
5 Guess
6 Lunar Lander

*Recommended for adults with some knowledge of basic securities transactions. Game is designed for two or more (up to 10) players.

NEW GAMES -- This cassette contains 6 additional games:
1 Computer Reader & Advisor
2 Flying Saucers (up to 4 players)
3 Space Challenge
4 GHOST -- a word game
5 Calendar
6 HANGMAN -- a word game

Side 2

1 Pizza Delivery Game
2 Biorhythm Analysis
3 Game of Life
4 Wonderama Snake Can Game

CONSUMER FINANCE -- This cassette contains 3 programs:
1 Balance Your Checkbook - This program reconciles a user's checkbook against his bank's statement.
2 Consumer Loans - There are two parts to this program. The first part displays interest rates and payment amounts for mortgage loans, auto loans, home improvement loans; or personal loans available from several banks in the White Plains area. The second part checks an actual loan for compliance with the requirements of the Federal Reserve Regulation Z (Truth in Lending Act).
3 Witholding - This program calculates your Federal, State, and City witholding tax.

HUNTINGTON I -- This cassette contains 7 educational demonstration programs in a variety of fields:
1 DECAY2 - (Physics) -- Solves problems involving decay of radioactive elements.
2 QUADRT - (Math) -- Solves for the roots of a quadratic equation.
3 CLIMAT - (Earth Science) -- A quiz program in climatology.
4 EQUIL1 - (Chemistry) -- Solves problems involving chemical equilibrium of solutions.
5 NZYMC - (Biology) -- Computes enzyme activity as a function of pH, temperature, etc.
6 STOCK - (Social Studies) -- Simulates stock market transactions.
7 AVERG2 -(Teacher Aid) -- Calculates class average grades.

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1. MICROPROCESSORS: New Directions for Designers by Edward A. Torrero, #5777-6, paper, 1975, 144 pp., 8½ x 11, illus., $10.95.

2. GAME PLAYING WITH COMPUTERS Rev. 2nd Ed., by Donald D. Spencer, #5103-4. cloth, 1976, 320 pp., 6 x 9, illus. $16.95.

3. FUNDAMENTALS AND APPLICATIONS OF DIGITAL LOGIC CIRCUITS by Sol Libes, #5505-6, paper, ($6.95), #5506-4, cloth, ($9.95), 1975, 192 pp., 6 x 9, illus.

4. COMPUTERS IN ACTION: How Computers Work by Donald D. Spencer, #5861-6, paper, 1974, 160 pp., 6 x 9, illus., $5.50.

5. COMPUTERS IN SOCIETY: The Wheres, Whys and Hows of Computer Use by Donald D. Spencer, #5915-9, paper, ($5.50), #5916-7, cloth, ($7.50), 1974, 208 pp., 6 x 9, illus.

6. PROGRAMMING PROVERBS by Henry F. Ledgard, #5522-6, paper, 1975, 144 pp., 6 x 9, illus, $6.50.

7. PROGRAMMING PROVERBS FOR FORTRAN PROGRAMMERS by Henry F. Ledgard, #5820-9, paper, 1975, 144 pp., 6 x 9, illus., $6.50.

8. COBOL WITH STYLE: Programming Proverbs by Louis J. Chmura, Jr., and Henry F. Ledgard, #5781-4, paper, 1976, 144 pp., 6 x 9, illus. $5.45.

9. MINICOMPUTERS: Structure and Programming, by T.G. Lewis and J.W. Doerr, #5642-7, cloth, 1976, 288 pp., 6 x 9, illus., $12.95.

10. PATTERN RECOGNITION by M. Bongard, #9165, cloth, 1970, 256 pp., 6 x 9 illus., $14.90.

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12. BASIC BASIC: An Introduction to Computer Programming in BASIC LANGUAGE by James S. Coan, #5872-1, paper, ($7.95), #5873-X, cloth, ($9.95), 1970, 256 pp., 6 x 9, illus.

13. ADVANCED BASIC: Applications and Problems, by James S. Coan, #5856-X, cloth, ($8.95), #5855-1, paper, ($6.95), 1976, 192 pp., 6 x 9, illus.

14. FORTRAN FUNDAMENTALS: A Short Course by Jack Steingraber, #5860-8, paper, 1975, 96 pp., 6 x 9, illus., $4.95.

15. DIGITAL TROUBLESHOOTING: Practical Digital Theory and Trouble-shooting Tips by Richard E. Gasperini, #5708-3. paper, 1976, 180 pp., 8½ x 11, illus., $9.95.

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Computer Power to the People!

The myth, the reality, and the challenge

David H. Ahl

The following is a lightly edited transcript of a presentation originally given at the "Man and the Computer" symposium at Dartmouth in December, 1976. Modified versions have also been given at several other educational and hobbyist conferences. Some 80 slides and graphics are used in the live presentation, most of which, unfortunately, cannot be reproduced here.

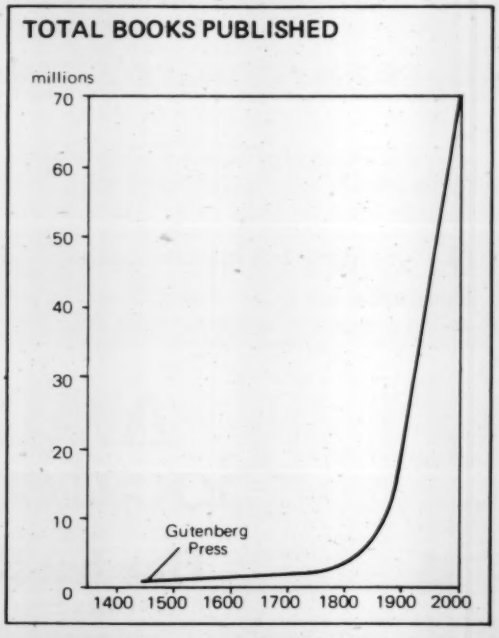
INTRODUCTION

We all know that computers are around us. They're invading our lives along dozens of dimensions. We see them in supermarkets—the little product code you find on the side of virtually every food and grocery product you buy can be read by an optical scanner connected to a computer. Computers in department stores—a little "magic" wand, actually a tiny laser device, reads a product code from the tag. Medical facilities—hospitals frequently keep all their patient records on computers. When you're admitted you often undergo some kind of questioning process. One psychiatric hospital out in Utah takes the entire patient with an on-line computer program. College admissions at, for instance, Fort Lauderdale Community College, and hundreds of others, use on-line computers. Every time you pick up the telephone and dial it you're actually using the largest general-purpose computer in the world—the switched telephone network. Magnetic-ink character recognition in the bank; sports stadium score boards; and so on.

My premise is that now, some 30 years or so after the invention of the computer, it's having a tremendous impact on our lives. It is having an impact on our lives similar to that of the printing press, but instead of taking some 400 years to make its effect known, the computer is having a vast effect in something like 20 or 30 years. We just can't escape it. So some thirty years after the invention of the computer we decided it would be a nice idea to find out what people think about computers. Do they view it as a master, a slave, a dictator, a monster? In fact, do people really understand what the computer is all about and what it's good for? We took a survey among both adults and young people with 17 different questions. We posed statements and asked them "Do you agree with this statement or disagree?', and got their responses. We also had some open-ended questions and we continue to ask people open-ended questions. Like, "if you had a computer in your home, what would you do with it?"

THE MYTH

First of all we asked some questions about what you might call the quality of life. Did people feel that the computer was going to improve various facets of society? For the most part, there was pretty good agreement that computers would improve education somehow, a very substantial agreement that computers would improve law enforcement, a little less agreement, particularly amoung younger people, that computers would improve health care; and some agreement that computers are worthwile for prevention of fraud through credit-rating data. This last one is interesting. The question was asked in the *AFIPS/Time Magazine* survey just four years before this one; the percentage of people that felt credit checking was a good application dropped from 74% to 64%, so 10% more people today have doubts in contrast to four years ago. I guess in four years many people have gotten stung in one way or another by credit ratings or other foulups.



The computer will have an impact similar to that of the printing press except should take 30 or 40 years instead of 400.

Do you feel you can escape the influence of computers?

Influence of Computers

We asked some questions about the threatening nature of computers. Do you feel you can escape the influence of computers? Well, people for the most part felt that they couldn't; a suprising number of young people felt they could. I'm not quite sure where they were going to go to do it, certainly not the United States. There was some feeling, particularly pronounced among West Coast respondents, that the computer could influence the outcome of elections. Senator John Tunney of California was one of the biggest critics of the use of computers to forecast the outcome of elections. Senator Tunney, if you'll recall, was defeated in November, 1976. I'm not sure if computer projections had anything to do with his defeat but, in fact, his fear was that by the time the voters went to the polls in the western states, the major national election would be locked up. In 1976 it wasn't quite locked up by the time they went to the polls, but frequently it is and therefore people may say "why bother" or "gee, there's a bandwagon; I want to get on it and vote for the winner." Or, "I was going to vote for the other guy, and he has lost, so I can't be bothered going to the polls." Well that may not affect the outcome of the national elections, but it has a tremendous affect on the outcome of local elections and local bond issues. So, John Tunney at least was pretty upset about using computers in the forecasting of election results.

"Computers dehumanize society by treating everyone as a number."

"Computers dehumanize society by treating everyone as a number." On that statement we had some ambivalence. Some people agree, some people disagree—certainly a substantial number of people are a little bit fearful and do feel like the computer is dehumanizing by treating them as a number.

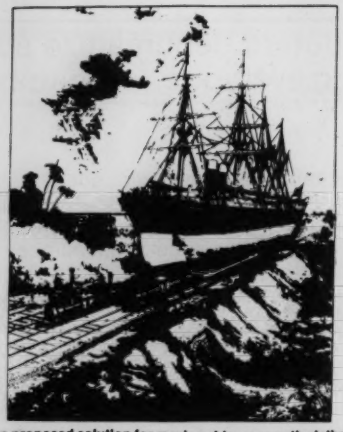
The Role of a Computer

We asked five questions to get at whether people understand the role of a computer. Do they really know what it's good for and do they know its applications? One of those statement was "computers are best suited for doing monotonous, repetitive tasks." Well, 80% of the adults agreed with that, although only 67% of the young people did, which gives rise to the hope that young people can see that computers are good for doing more than just dull, repetitive tasks. Are computers a tool? Yes—a pretty substantial agreement that they are a tool. I think that's a good thing. But I think it matters a lot whether people view it as an intellectual tool or whether they are thinking of it as a plain, ordinary tool such as a hammer, for example.

Do computers slow down and complicate simple business operations? Some people felt that they did—I'm not quite sure who. There's a substantial agreement that computers are going to replace a lot of jobs and create jobs that need specialized training, and some

Statistical Results of Survey of Public Attitudes Towards Computers in Society.

	ADULT (N=300)		YOUTH (N=543)	
	Strongly or Mostly Agree	Strongly or Mostly Disagree	Strongly or Mostly Agree	Strongly or Mostly Disagree
Computer Impact on the Quality of Life				
• Computers will improve education.	86.6%	5.9%	84.2%	4.5%
• Computers will improve law enforcement.	81.9	3.3	70.0	10.1
• Computers will improve health care.	78.6	5.3	54.1	11.9
• Credit rating data banks are a worthwhile use of computers.	64.2	13.4	64.0	7.6
Computer Threat to Society				
• A person today cannot escape the influence of computers.	91.6	4.0	66.6	17.7
• Computer polls and predictions influence the outcome of elections.	48.1	27.5	44.2	26.9
• Computers dehumanize society by treating everyone as a number.	37.4	50.3	39.9	30.6
• Computers isolate people by preventing normal social interactions among users.	18.7	62.5	20.9	42.5
Understanding the Role of Computers				
• Computers are best suited for doing repetitive, monotonous tasks.	80.0	10.3	57.0	21.6
• Computers are a tool just like a hammer or lathe.	72.6	14.7	61.3	23.4
• Computers slow down and complicate simple business operations.	17.6	66.4	17.4	68.8
• Computers will replace low-skill jobs and create jobs needing specialized training.	71.0	15.0	61.8	14.4
• Computers will create as many jobs as they eliminate.	62.5	16.4	40.0	29.1
Understanding of Computers				
• Computers are beyond the understanding of the typical person.	25.2	61.6	30.6	49.2
• Computers make mistakes at least 10% of the time.	9.6	76.7	10.3	60.0
• Programmers and operators make mistakes, but computers are, for the most part, error free.	67.0	19.3	72.3	13.3
• It is possible to design computer systems which protect the privacy of data.	60.2	26.4	48.6	15.9



In 1884 this was the proposed solution for moving ships across the Isthmus of Panama.

people really fear that they might not be qualified for the jobs that will exist after the "computer revolution." Also on the jobs issue, we asked whether people feel that computers will create as many jobs as they eliminate? About two-thirds agree, but that leaves a fair number that disagree. You have to remember that people have always been fearful of any kind of industrialization or technological breakthrough. The Luddites were anti-technology—to them the industrial revolution meant the machines were going to take all the jobs. Well, it just didn't quite work out that way and I don't really think computers are going to take all the jobs either.

Then we asked a couple of questions to see if people really understand the computer itself. We first asked, are computers beyond the understanding of a typical person? The response was mixed. At least a quarter of the people think that they are beyond their understanding, but I'm encouraged by the larger percentage of people who disagree. "Computers make mistakes at least 10% of the time." You have to feel sorry for the 10% of the people who do think that computers make mistakes this often. In fact it is the programmers and operators who make the mistakes and not the computers. But in these questions we gleaned a little bit of intelligence that someplace between 13 and 19% of the people just actually don't know who's running them. They think the computers are running the people, rather than the other way around. A substantial number of people just didn't know, which is also upsetting. So,

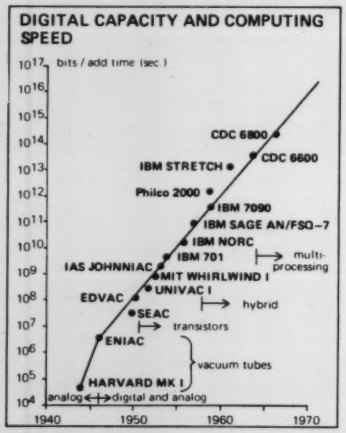
What would you do if you had a computer at home?

there's a substantial portion of our society—at least a third or so—that just doesn't know some of the fundamental issues and facts about computers. We asked one last question—is it possible to design computer systems to protect the privacy of data? Well, not even the computer designers know for sure, so I don't think we could expect much from people that we asked.

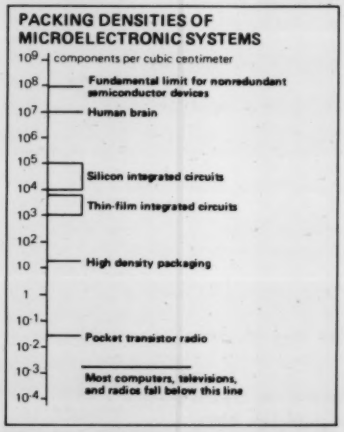
All in all, we have some ambivalence, people optimistic on some counts and pessimistic on some other counts and some things that they just don't know. The ignorance is probably most apparent when you ask someone what would you do if you had a computer at home? A computer? What do you mean a computer? You mean like a hand calculator? Some people thought we meant robots. "Well, maybe I'll have it serve me martinis when I come home from work." They just couldn't quite visualize a computer at home. A computer is supposed to be something that goes behind glass doors and is raised on flooring and requires a lot of electricity. "I don't have the kind of home that would suit a computer," said one.

Everyday Perceptions

I guess this mixture of attitudes really shouldn't be too surprising. The everyday perceptions of a computer are formed by people in the media and elsewhere who really don't know what computers are all about either. For example, newspapers, comic strips, TV, and so on. What does a newspaper cover? They're going to report the computer error, the problem with the computer. A New Jersey supermarket had brand-new laser scanning systems at the checkout for the grand opening day and they really crammed the people in. Hundreds of people all filled their carts with these grand opening specials. People were lined up at the cash registers, each with two and three carts full of groceries. Seven or eight deep at every cash register and all of a sudden, bang, the system went down. Well, not only did it go down, but it locked all the cash drawers. So there was no way of making change. They couldn't use the cash registers manually. There was just no way of opening them up. Rumors started flying around. People said, "The cash drawers are locked, the doors are going to lock too;



Ever since the first pure digital computer, internal speeds have increased by an order of magnitude (x10) every 2½ years.


PACKING DENSITIES OF MICROELECTRONIC SYSTEMS
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Fundamental limit for nonredundant semiconductor devices
Human brain
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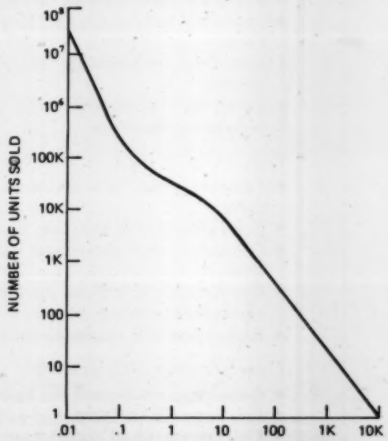
Thin-film integrated circuits
High density packaging
Pocket transistor radio
Most computers, televisions, and radios fall below this line

In 1953, a computer 'CPM) weighed approximately 5000 pounds, occupied 300-400 cu. ft. and required 40 Kilowatts of power. Compare that to today's microprocessor on a chip!



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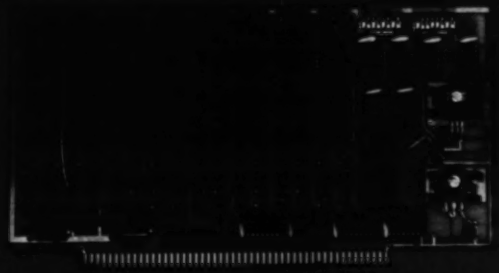
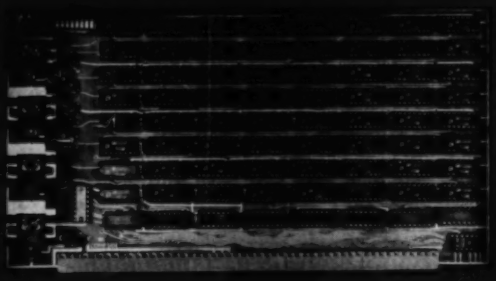
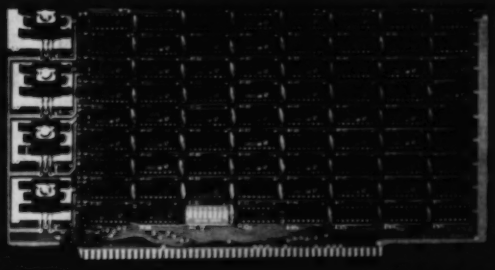






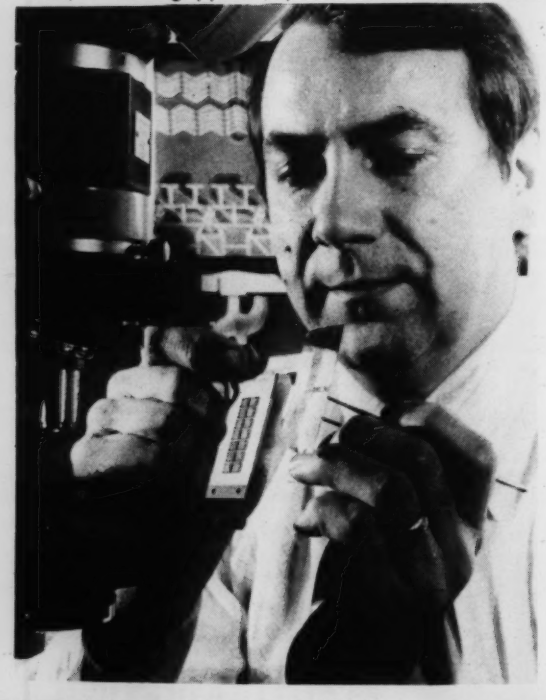
SEALS ELECTRONICS, INC.
TELEPHONE # 615/693-8655

ORDER DELIVERY: FROM STOCK TO 10 DAYS

we're going to be locked in here forever." And then there was a rumor that a replacement computer was going to have to be shipped in from Texas and they'd have to wait until it arrived! It was wild. Finally the manager decided that the best course of action was to give each checker a pencil and some brown paper bags, and have them add up manually the groceries in these laden carts. People were there for *hours.* The interesting thing is they did not lock the doors and more people kept streaming in. The manager didn't want to lock the doors because of this panicky rumor inside the store that if we lock the doors we might be stuck here. They didn't want to start a riot. Well anyway, the newspapers had a field day with the story.

Most of you have heard about the friviality out in Southern California when McDonalds had a sweepstake. To enter, all that was required was a 3 × 5 entry form or facsimile. In other words you could write the entry on a 3 × 5 card of your own. Students at one fraternity programmed the computer to produce entry forms—1.2 million of them—and then they stuffed every McDonalds ballot box in Southern California. They won 90% of the prizes in the contest. McDonalds was very upset about it—they said it was anti-American. I think it was very American; it showed a lot of ingenuity and creativity. In fact, McDonalds awarded duplicate prizes to people that were not members of this conspiracy to defraud them. The winning fraternity invited Ronald McDonald to make the prize presentations over at their fraternity house for dinner, but he declined the invitation. Actually, Burger King got the best publicity out of this. They gave a $3,000 scholarship to the university in memory of the prank. Again, the newspapers had a wonderful time blaming the whole thing on a computer.

A college student at the University of Arizona insured the life of his guppy. He put down all the correct information on the mail order insurance form—height 3 centimeters, weight 30 centigrams and so on. It died of course, as most guppies do, some four or five months later. He submitted a claim for the $5,000 he had insured it for. The insurance company said it was an invalid claim—the computer had made a mistake in accepting this "person." Well the computer hadn't made a mistake—it was a programmer who hadn't allowed for somebody that was 3 centimeters high. It wasn't the computer. But the newspaper, how did they portray it? Sure—another computer error.



This new "bubble" memory developed at Bell Labs can store the information equivalent of 27,000 telephone numbers.

Visual communications over ordinary telephone lines is in the works. At Bell Labs a Flat-Screen video device can be used to transmit handwriting instantaneously.

In Swansea, Wales, a young man of 17 applied for a driver's license and passed his test shortly after. But when his license arrived, it bore 12 endorsements for a whole array of driving offenses, plus a 28-day driving suspension. Police proved sympathetic when it was found that "the computer at the license office had run wild. The system has not been operating for long," said an official.

There was a cute little notice printed recently in the *Chicago Tribute.* "A COMPUTERIZED bill had this notice on the bottom: Failure to receive this bill is no excuse for non-payment of the amount shown." Why capitalize "computerized?" Does that mean the computer printed that notice on the bottom of the bill. As if the computer could have made that up out of the blue sky? The computer is the scapegoat for the post office now—that's what's really happening!

A woman in Shreveport, La. got a gas bill for $42,474.58. A customer representative at Arka Gas Co. stated, "The computer went haywire and some of those bills got out." Computer error? Hardly. Good for the newspaper? You bet!

Movies and Books

Movies are another way that people form perceptions of the computer. For example, in *2001*, remember when Commander Bowman finally gains access to the memory banks after Hal has been harrassing him for half the trip and he yanks out the circuits one at a time. Finally, Hal breaks down as Bowman performs the first successful interplanetary lobotomy. The movie *Colossus*—have you seen that one? Colossus "wakes up"

MICROPROCESSOR COMPONENTS

CPU'S

8008-1 (18 Pin)	8 Bit CPU (PMOS)	$17.95
8080A (40 Pin)	8 Bit CPU (2us) (NMOS)	24.95

8080 SUPPORT DEVICES

8212	8 BIT I/O Port	$ 4.25
8214	Priority Interupt Control	8.95
8216	Bi-Directional Bus Driver	4.25
8224	Clock Generator	8.00
8255	Programmable Peripheral Interface	12.00

ROM'S

74S387	1024 Bit Programmable	$ 2.50
MM5230	2048 Bit	1.95
DM8796	4096 Bit	10.00

PROM'S

82S23	32 x 8 Open Collector (Schottky)	$ 3.00
1702 A	2048 Bit (512 x 4) (1us) Erasable and Electrically Reprogrammable	5.00
1702AL	2048 Bit (512 x 4) (LO-PWR) (1us) Erasable and Electrically Reprogrammable	7.00
2708	8192 Bit (1024 x 8) Erasable and Electrically Reprogrammable	40.00
8223	32 x 8 Open Collector	3.50

SHIFT REGISTER'S

MM506N	Dual 100 Static	$ .89
P-2405	1024 Dynamic	4.95
N2518B	Hex 32 Bit	3.95
N2533V	1024 Static	3.95
MM5013N	1024 Bit Accumulator Dynamic	2.00
MM5017N	Dual 500/512 Dynamic	2.00
MM5058	1024 x 1 Static	2.50
TMS3002LR	Dual 50 Static	3.00
TMS3132NC	Dual 144 Static	2.00

CALCULATOR CHIPS

MM5736	6 Digit Cal.	$1.25
CT5001	12 Digit Cal.	1.75

With Specifications

RAM'S

21L02	1024 x 1 Static	$1.58
1101	256 x 1 Static	1.00
1103	1024 x 1 Dynamic	1.50
2101	256 x 1 Static (1us)	3.00
2102	1024 x 1 Static (1us)	1.50
2102-1	1024 x 1 Static (500NS)	1.65
2107B	4096 x 1 Dynamic (200NS)	6.50
2107B-4	4096 x 1 Dynamic (270NS)	5.00
2107B-6	4096 x 1 Dynamic (350NS)	4.50
3107	256 x 1 Static (80NS)	2.95
3107A	256 x 1 Static (60NS)	3.50
4050NL	4096 x 1 Dynamic (300NS)	4.00
5261	1024 x 1 Dynamic (400NS)	3.00
5262	2048 x 1 Dynamic (365NS)	3.00
5280	4096 x 1 Dynamic (200NS)	4.00
7489	16 x 4 Static	1.50
8599	16 x 4 Static	1.50

MISC. OTHER COMPONENTS

N8T20	Bi-Direc-tional One Shot	$4.00
N8T26	Quad Bus Driver/Receiver	3.25
N8T97	Tri-State Hex Buffer	1.45
1488	RS232 Quad Line Driver	1.25
1489	RS232 Quad Line Receiver	1.25
D3207A	Quad Bi-Polor to MOS Level Shifter/Driver	2.50
C-3404	6 Bit Latch 12NS Output Delay	3.95
P-3408A	Hex Sense Amplifier W/Latch	6.75
P-4201	Clock Generator	4.95
MM-5320	T.V. Camera Sync. Generator	6.00
MM-5369	Oscillator Pre-scaler	2.00
MC-6850L	Asynchronous	
DM8130N	Ten Bit Comparator	2.25
DM8131N	6 Bit Comparator	2.00

DISPLAY LED'S

Type	*Polarity*	*HGT.*	*Price*
MAN-4	Common Cathode	.187	$ .75
ILD-74	Logic Drive Opto-Isolator	(8 Pin) (8 Pin)	1.00
DL-707	Common Anode	.300	1.25
DL-747	Common Anode (Jumbo)	.60	2.00
TIL-113	Opto Coupler	(6 Pin)	2.00
TIL-302	Common Anode (LORR DEC)	.27	1.00

TTL PRODUCT

7400	.14	7441	.85	7496	.65	74160	.86
7401	.20	7442	.44	7497	2.00	74161	.62
7402	.20	7443	1.20	74100	1.25	74162	1.00
7403	.20	7445	.89	74107	.76	74163	.76
7404	.20	7446	.87	74109	.35	74164	.80
7405	.20	7447	.69	74110	.50	74165	.90
7406	.39	7448	.81	74116	2.00	74166	1.00
7407	.39	7450	.20	74120	1.25	74167	3.00
7408	.20	7451	.20	74121	.34	74170	2.00
7409	.24	7453	.20	74122	.39	74172	9.72
7410	.20	7454	.20	74123	.50	74173	1.25
7411	.20	7460	.20	74125	.45	74174	.85
7412	.24	7470	.20	74126	.45	74175	.75
7413	.35	7472	.23	74128	.65	74176	.85
7414	.70	7473	.26	74132	.95	74177	.85
7416	.33	7474	.29	74136	.50	74180	.75
7417	.33	7475	.39	74141	.80	74181	2.00
7420	.20	7476	.31	74142	4.00	74182	.90
7422	.50	7479	1.50	74143	3.00	74184	1.65
7423	.28	7480	.69	74144	4.00	74185	1.30
7425	.24	7482	.72	74145	.70	74186	5.00
7426	.24	7483	.75	74147	2.50	74190	1.00
7427	.24	7485	.90	74148	1.75	74191	.65
7428	.40	7486	.25	74150	1.00	74192	.85
7429	.40	7488	3.50	74151	.70	74193	.85
7430	.20	7489	1.50	74153	.70	74194	1.20
7432	.28	7490	.39	74154	.90	74195	.55
7433	.34	7491	.65	74155	.70	74196	.80
7437	.28	7492	.39	74156	.90	74198	1.50
7438	.28	7493	.39	74157	.70	74199	1.75
7439	.36	7494	.70	74158	1.75	74200	3.50
7440	.20	7495	.50	74159	2.25	74279	1.75

LINEAR

LM308N(8)	Micro Power Op Amp	$ .75
LM311N(8)	Hi-Performance Volt. Comp.	.95
LM318N(8)	Precision Hi-Speed Op Amp	1.95
LM324N	Quad 741 Op Amp	1.00
LM339N	Quad Comparator	.75
LM380N	2 Watt Audio Power Amp	.60
LM381N	Low Noise Power Amp	1.95
NE555V	Timer	.60
NE566V	Function Generator	2.00
NE567V	Tone Generator	2.00
NE723CN	Voltage Regulator	.50
NE739N	Dual Hi-Perf. Op Amp	1.00
NE741CH	Compensated Op Amp	.45
NE741CN	Compensated Op Amp	.35
NE1458CN	Dual Comp Op Amp	.65
NE3900N	Quad Amp	.45

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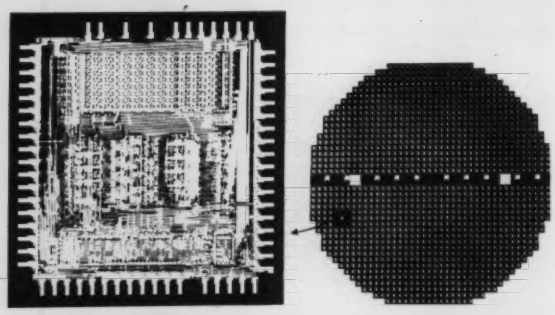


A mask for the Electron Beam Exposure System contains 1304 logic circuits, each of incredible detail. As circuits get smaller, the prospect for a "Dynabook" becomes more real.

and gains sentience very much like the computer did in Heinlein's book, *The Moon Is A Harsh Mistress.* Well, Colossus gains it while it's hooked up to its Russian counterpart. The computers are in charge of the National Defense Systems of both countries and the two computers decide between them that it would be kind of neat if they held the population of both of their countries hostage. A movie that will be coming out shortly, called *Demon Seed,* has a computer in it, Proteus IV (appropriately named) equipped with an ominous blue enforcer arm with which the computer keeps people hostage, mainly Julie Christie in the movie (that probably makes it worth seeing even if you don't like computers). Three movies and three impressions of computers—all false.

Some people get their images of computers from books (not too many because not too many people bother to read books anymore). Science-fiction writers are probably the only writers in the country portraying future computers uses reasonably realistically and making some half-decent speculations. Unfortunately, very few people read science fiction, so we don't have to worry about many people getting a realistic view of computers from that source.

Consequently we know a little bit from the survey what people think about computers and little bit of how these impressions were formed from my rather incomplete discussion of it, but I think you can fill out the missing pieces. We know too that if we ask the average person what would you do if you had access to a computer or if you had a computer in your home he really doesn't have a very good idea. In fact neither do many professionals or manufacturers. The fact is that we're really not very good at forecasting the future. We really can't and never have forecasted future technological innovation or invention very well.

Back around the turn of the century who would have forecasted life today as it actually is? In those days the best guess of what the Panama Canal would be, was a railroad pulling ships across the isthmus. Back in those days it probably seemed reasonable. I'm sure if the Wright Brothers had asked the drivers of ox carts what they would do with an airplane they probably couldn't have given them a very good idea. Henry David Thoreau, one of our leading philosophers commented, when he was told that the telephone would permit people in Maine to talk to people in Texas, "but what does a man in Maine have to say to a man in Texas?"

THE REALITY

It's pretty clear that we can't forecast 70 or 50 or probably even 30 years very well, particularly with a high-technology item such as a computer. So let's just look five to ten years into the future. Even so, we can't foresee exactly when everything is going to occur. We would certainly expect that processor instruction speed would continue to increase very rapidly. Packing density will also continue to increase dramatically. Currently, we are within two orders of magnitude of the human brain. Actually, the theroretical density limit for semiconductor devices is higher than that of the human brain. Currently, bubble memory circuits in Bell Laboratories, about 1 centimenter square, will store about 1.5 million bits.

Coupled with miniaturization, prices are rapidly falling. Let me tell you that more than one manufacturer is a little bit alarmed at the projection of hardware prices approaching zero. The indication is that as the prices come down, the numbers of units sold goes up very dramatically. This applies not only to calculators but to computers as well. What happens as prices come down? What do you think the value of this ratio is today?

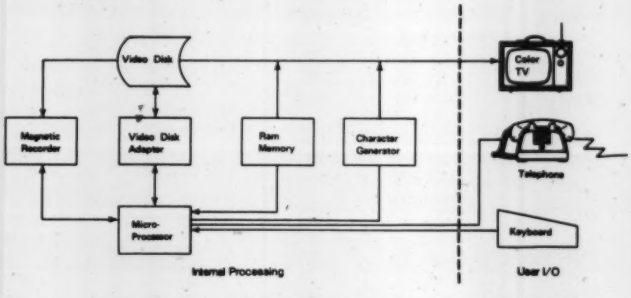
$$\frac{\text{Cost to program 1 line of code}}{\text{Cost to execute 1 line of code}}$$

One hundred to one? A thousand to one? ten thousand to one? Wrong. IBM says the ratio is 100 million to one, and that was two years ago! Given the current increases in processor speed, it's probably a lot more than that today. What that indicates, of course, is that the human element is by far and away the most important thing in computers and technology today, in making them all work.

So what does all this mean when you put all this technology together? Well, obviously it means smaller terminals, terminals that fit in your pocket. Sophisticated and very small color video cameras. Calculators with as much power as a computer of 20 years ago. Hobbyist computer kits that are within the price range of a quarter of the households in the U.S. Close to 30,000 hobbyist computer kits have been sold as of the end of 1976. Technology means people talking to other computers and terminals by means of the telephone network, using standard Teletype terminals or new high-speed terminals or plasma panels built into your phone. A panel that can be written on with a light pen or typed on; or display information from a computer, data bank, directory, or from local storage.

Personal Computers

Today there are over 100 manufacturers of personal computers and peripherals. At *Creative Computing* we



Future Home Computer System

Consumer electronics manufacturers are currently evaluating systems like this for the home.

can't possibly keep up with all the new-product announcements for new hobbyist computer kits and peripherals. We started a new-product section in early 1975 and the hardware portion was about one page. In the Jan-Feb 1977 issue it ran 9 pages of closely-spaced descriptions of new hardware. It's a revolution. Two hundred computer stores open now and a new one opening every four days. Retail computer stores where you go buy yourself a microprocessor, a computer kit, or peripherals.

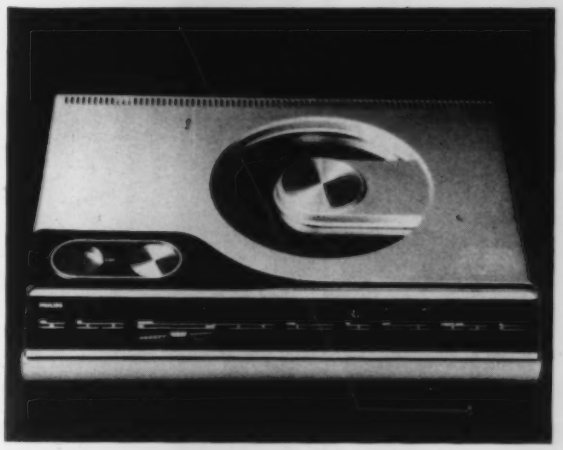
Extensible, user-defined, simple languages are being developed. Harvard has a new language called ECL. It's not like today's simple languages, say BASIC or LOGO. ECL doesn't use constructs that have to be absorbed into your intuition but rather you use concepts that are already part of your intuition, part of your language, and then you construct the computer language out of that. Whether you're a banker, a baker or a professional programmer, you can produce a computer language that does exactly what you want.

Dynabook

Out at Xerox's Palo Alto Research Center they've got a thing called the "Dynabook." The original idea was that Dynabook should in every way be better than a book. It can display printed pages on its screen: black on white, white on black, red on green, etc. it can display pages in any style and size of typeface. If you have some visual problems and you want a page in large type, Dynabook displays it in large type or for reference material it can use very small type. Not only can you read things but you can write things on it. You can just draw a circle around a word and move it to someplace else with a little arrow and the computer moves it for you. You can edit your material from a keyboard if you'd rather. You can strike-over lines and they disappear. The next time you push a button you get all your text nicely justified on the screen. Actually, it's better than a book in every way because you read it, you can write it, and you can change it. It's also better from the graphical sense. It would be nice if the illustrations in a book could move with full animation. In fact not only can they move the way that they're programmed to move, but if you'd like them to move in some special way, you simply take your light pen and draw over the illustration and let the computer sequence through your frames. This is reality. This is here today. It's not quite the size of a book today; it's about the size of three bread boxes but it's not going to be too long before it's the size of a book. In addition to having book qualities, it's also a general-purpose computer with the ability to do parallel processing on eight different levels. When you think of it, that's the way human beings think. When I'm walking along, for example, one part of my brain is thinking about putting one foot in front of the other, another part is thinking "it's cold out, I'll be glad when I can get inside, another part is thinking about the speech I'm going to give tonight, another part is thinking about the person I'm talking to and still another is thinking about the beer that I'll have later on and so on. So your brain is processing information on a parallel basis all the time. Well, wouldn't it be nice if you could have a computer that could do that too and have the output of one level serve as the input to another. That's precisely what Dynabook provides. It's a phenomenal machine. I'd like to think that within 10 years it will be as commonplace as the pocket calculator is today.

Video Disc

I feel one of the keys for getting computers into the home at least is the widespread availability of cheap high-quality software. One possible vehicle for bringing this about is the video disc.



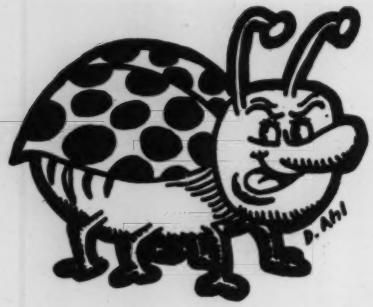
Videodisk players should cost around $500. Each disc can store 10^{10} bits of information in binary format.

Quite inadvertently, a stroke of luck perhaps, the storage technique employed by the disc is binary, or digital. Just what's needed for a computer. So while the player will be brought into the home for entertainment, its real power lies in the fact that if you couple the videodisc system with a microprocessor and keyboard you have incredibly powerful audio/visual/computational/educational/recreational device. One videodisc can store 10^{11} bits of information, the entire Encyclopedia Britannica for example, or a very comprehensive software library. You could have Jackie Stewart introducing the Monaco Grand Prix, taking you on a pre-recorded ride around the circuit, and then turning the controls over to you. Or Kirk handing you the controls of the Enterprise just as the Klingons are about to attack. Or Fran Tarkington coming off the field and putting you in as quarterback in the Super Bowl.

THE CHALLENGE

There's no question that in five to ten years, solid-state and related technologies are going to put some fantastic things well within the reach of everyone who want them. It's equally clear that most people have little idea of what they'd do with a computer if they had one. Hence, we have quite a chasm between the insiders (those who have learned about computers from school, work, or hobby) and the outsiders who don't know much about computers and don't really care (today).

It would be nice to think that this chasm could be bridged by education (like the new math or metric system?), but it's not likely that schools will really face up to computers until every kid has his own (pocket calculators all over again). Business and industry are so wedded to large EDP Systems, with most DP Managers pretending that microcomputers are just toys, that we can't expect any help from that quarter. Most likely it will be the people, plain ordinary folks, who see a friend with a computer and decide to get one of their own., And as this increasingly happens, we're going to have the most massive domino effect you ever saw—calculators and CB move over—you ain't seen nothing' yet. Computer power to the people is on the way! ●



Still a Few Bugs in the System

It bugs us here at *Creative Computing* when the mass media blame various problems on the computer. Even people in government, business, and schools find the computer a convenient scapegoat for problems actually caused by a programmer, keypuncher, faulty data collection techniques or other non-computer facets.

In this continuing column, we'll reprint articles or quotes which blame various catastrophies or problems on the computer. It's up to you, the reader, to decide whether the computer is actually to blame. Also, if you spot an appropriate item for the "Bugs" column, please sent it in.

Computer Fills Hotel With Angry Rumors

CHICAGO, Jan. 8 — Four thousand persons received letters yesterday thanking them for staying at the Oxford House, a downtown Chicago hotel.

Unfortunately, the 4000 letters had gone to the wrong addresses.

A computer error sent letters intended for Oxford House clients across the nation to 4000 Chicago residents. And in that friendly way computers have, each letter addressed the recipient by his or her first name.

"The phone hasn't stopped ringing all day," said Jerry Belanger, general manager of the hotel.

"One woman who received the letter is expecting her fourth child. Now she says her husband doesn't believe it's his," he moaned.

"Another woman who is suing her husband for divorce thought she might have some incriminating evidence to use. She was very upset when she found that the letter was a mistake.

"Some men called and demanded a retraction while their wives listened in on extension phones.

"The husbands were really the most irate. They got the letters but their wives opened them. Some couples said it was destroying their home life."

More than a few callers threatened lawsuits.

Belanger thought the mess had something to do with a mix-up in computer tapes by a letter-mail firm that had purchased address lists of department store credit card holders.

He said the computer was composing a letter of apology.

The Chicago Daily News

Unexpected Bonanza Thanks to Computer Error

ST. PAUL, Minnesota, Sept. 23 (AP) — It seemed like a bonanza to Joseph Pearson and his wife. The checks which came at intervals to his St. Paul home from the state totaled more than $25,000. Pearson says, "I saw 'Education Department' on the checks so I assumed they were from the Division of Vocational Rehabilitation. I didn't question them. I thought it was something I had coming."

The 52-year-old Pearson — who now manages several apartments — had injured his back on a construction job in 1969 and had been out of work for two years. He began taking a state rehabilitation program for job retraining. He dropped out of that in 1972. Three years later, the checks started coming.

The first check arrived in January 1975. Pearson thought it was a payment of benefits from the state because he couldn't work and had failed in the retraining program. Another check arrived in May of 1975. Then in September 1975, there was a check for more than $22,000. The fourth check arrived last May.

Pearson says, "I partied. I vacationed. I bought clothes and things that my wife and daughter didn't have during hard times."

Now Pearson is being sued by the state for the proceeds of the four checks that had been made out to him by mistake.

William Frietag, Superintendent of the Chandler, Minnesota school district, noticed a shortage of $25,585.76 in the state Transportation Aid account for his district. Pearson and the school district had been assigned the same computer number and the checks went to Pearson.

Michael Bradley, an Assistant Attorney General assigned to the state Department of Education, said it is the only instance in state history of such a computer error.

Computer Produces Shocking Invoice

So you think you have insurance bills? In Miami, Florida Baron Vladimir Kurt von Pousental received a shocking invoice for $5362. The 81-year-old motorist complained it was a bit steep for his 2-year-old chauffeured car. He also pointed out that his chauffeur had not collected 70 points for traffic violations as his insurance company claimed. The company replied that it was the computer's fault — one zero too many against the chauffeur.

Road and Track

Bankrupt by Computer, Frenchman Wins $300,000

GRENOBLE, France, July 17 (Reuters) — A fruit and vegetable wholesaler has been awarded $300,000 in damages after being driven to bankruptcy by a bank's computer error.

The computer of the state-owned Credit Lyonnais persistently rejected Eugene Rochette's checks to his suppliers on the ground of insufficient funds.

The suppliers protested to Mr. Rochette, who found his business, mainly with supermarkets, crumbling. Within weeks he was declared bankrupt.

Last year a lower court granted him $150,000 damages. The bank appealed, and an appeal court doubled the amount.

Woman Billed for Computer Goof

WASHINGTON — Though it wasn't her fault, a woman in New York owes the government $312 because a stupid computer put too much into her Social Security checks over a four-year period.

—The Wall Street Journal

Action Line

I received a notice from Social Security that my Survivor's Benefits were being terminated because I was no longer a fulltime student. I can't understand this because I'm registered at Henry Ford Community College for the fall semester so I should be eligible. I tried to find out what's going on but all I got was the runaround. Will you please look into this?—D.M., Dearborn Heights

Somehow computer convinced itself you were no longer continuing student, notified Social Security office personnel to send termination notice. Rejection meant you were broomed from benefit pool and Social Security stopped check flow effective August. Proper forms reinstating you are already in works and Social Security folks told Action Line you should receive $609 benefit check—covering August, September and October—in few weeks.

(From the *Detroit Free Press*. Thanks to Paul McCullough, Flint, Mich. for sending this in.)

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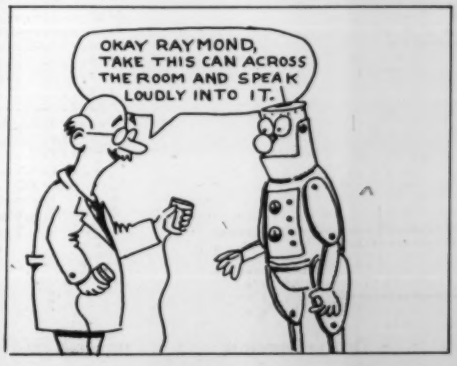
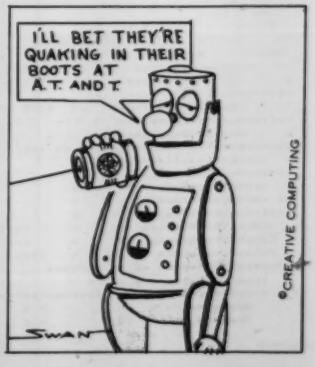




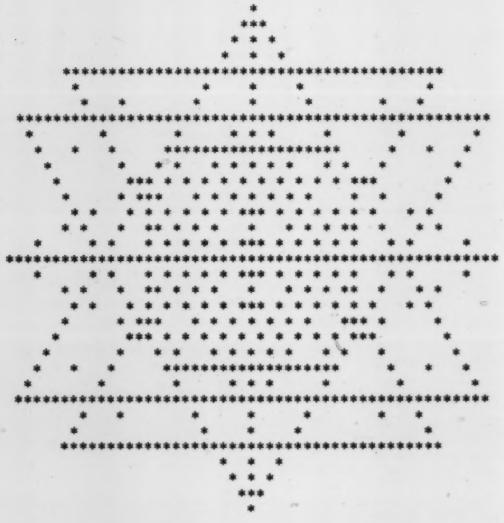
A Picture In 20 Lines

by E. Young
Beavercreek High School
Xenia, Ohio

We've all heard that a picture is worth 1000 words. Well what kind of picture can be produced in a 20-line BASIC program (approx. 1000 characters).

My assignment to my first-semester computer science class was simply "to produce a picture with a 20-line BASIC program with no PRINT quote formats allowed."

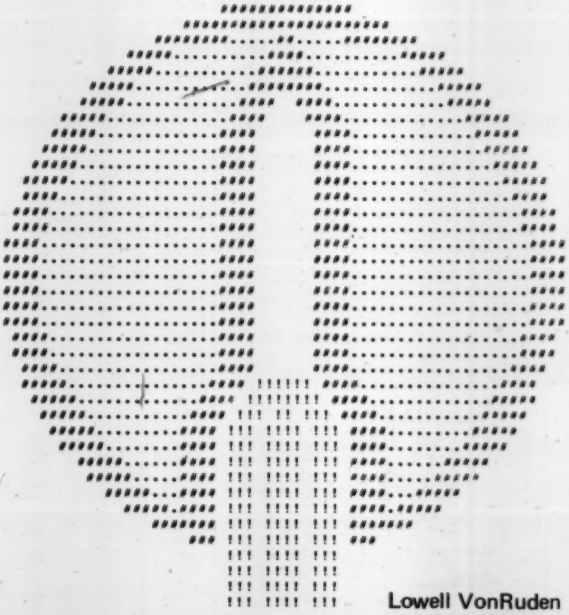
The variety of programming methods surprised me. They ranged from 3 data codes for what, where, and how many characters to read — to single numerical data that was sectioned algebraically to code a whole line.



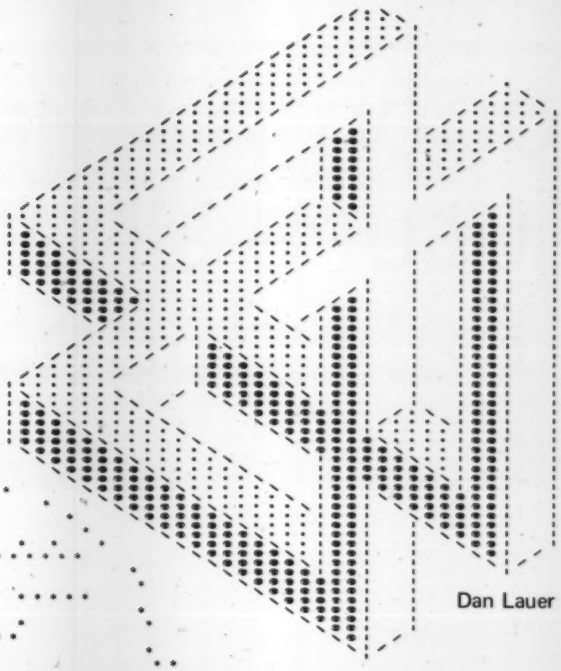
Star of Beaver Creek by Dave Triwush

Susan Gordon

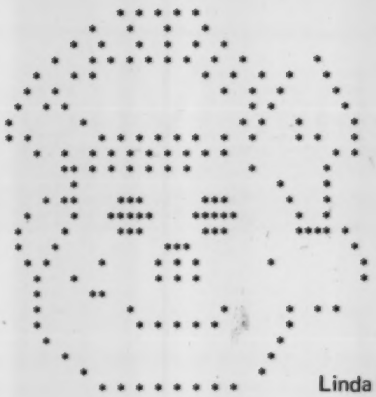
Dottie Dimiduk



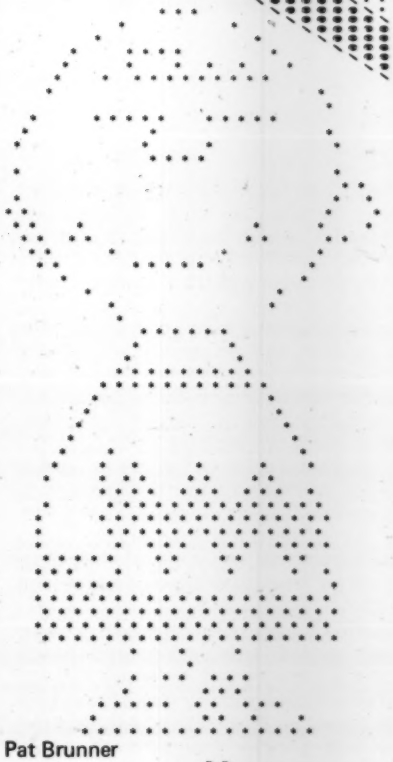
Lowell VonRuden



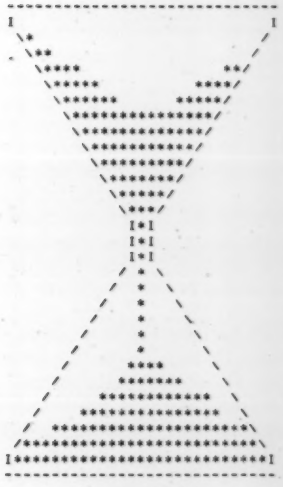
Dan Lauer



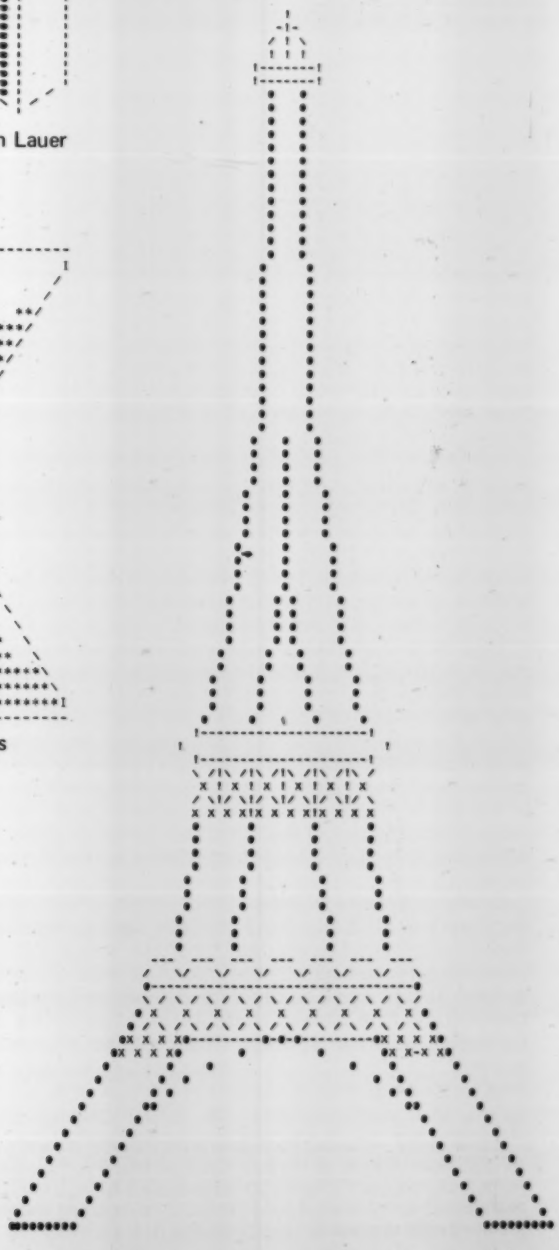
Linda Bailey



Pat Brunner



Norman Hicks



Ken Blauvelt

The Microcomputer Inflicts "Future Shock" on Technical Education

Richard Vuillequez

The microprocessor is forcing technical educators to reappraise the traditional methods for teaching digital electronics and computer programming due to the convergence in course content. The "computer-on-a-chip" has created a demand for new teaching aids and texts to satisfy people of all ages and experience levels who want to understand the computer but have neither the time nor desire to master all the formal engineering prerequisite courses.

Educators have become increasingly critical of the traditional linear approach to teaching computers, where the student must progress through a number of theoretical courses on devices and analog circuits before being introduced to digital technology and the fundamental logic elements of the computer. Especially since this appoach forces programming itself to be considered an independent subject.

This time-consuming approach may be excellent preparation for the student planning a career in electronic design, but for many other students with specific academic interests and career goals and a desire to utilize the computer for their purposes, it delays computer comprehension and utilization until well along in the curriculum. Students are frustrated by—and critical of—the traditional methods of teaching this evolutionary tool and report that after thousands of dollars of schooling they find themselves unable to use the computer.

Some professors report that even their ablest engineering students have trouble "tying together" their background knowledge in hardware and software to make effective use of the microcomputer in actual system design work, so rapid have been the changes in technology. The ablest students in engineering and computer science undergo the feelings of "future shock."

Editor's note... Richard Vuilleguez is from Derby, Ct. and works for E&L Instruments. In the past Creative *hasn't run articles by manufacturers, but Richard's article discusses an important point in shaping future trends of public access to computing and we felt it belonged in this issue.*

Many people are now fulfilling their desire to use the computer with informal seminars that bypass much much of the material being offered in the rigid traditional courses.

The special microcomputer seminars have seized the initiative and have married the essentials of digital logic, computer architecture and programming into one unified course suitable for everyone from beginning hobbyists to seasoned professional circuit designers seeking an update in the new technology.

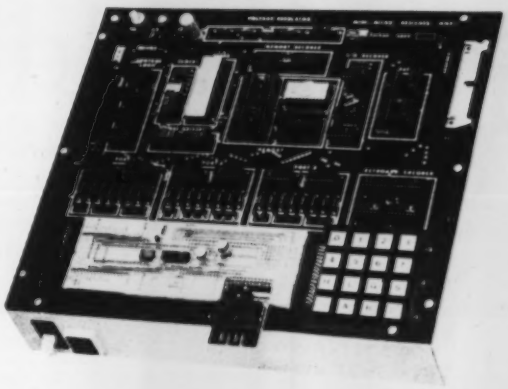
The focal point of this revolution in education is the self-contained, desk-top microcomputer built around a popular microprocessor central processing unit (CPU) chip and a matched set of interface, memory and control chips. They may be sold factory-built or they may be assembled and wired from kits by instructors or students.

A completely assembled unit with keyboard, status lamps, power supply and a reasonable amount of read/write and read-only memory will typically sell for less than $500. Some have provision for breadboarding for interface experimentation. The student will be able to write and carry out simple programs to solve mathematical problems or even control motors, relays or lamps. The trainer is a simple, yet functionally complete computer that is easier to comprehend than a minicomputer and gives the student complete control over both hardware and software.

Crucial issues in the selection of these training aids are the quality and educational level of the accompanying instructional text and the provisions for "hands on" experience in interfacing the microcomputer with external system components. Some trainers are "closed" systems, essentially limiting computational results to a lamp display. Some are also accompanied by manuals or handbooks largely devoted to the internal workings of the chips and incomprehensible except to those with current knowledge of large-scale integration device/specifications.

Professional educators favor the systems that can be employed both as classroom instruction aids for demonstration purposes and for self-instruction where existing curriculums do not permit formal instruction.

The microprocessor is forcing technical educators to reappraise the traditional methods for teaching digital electronics and computer programming.



E & L Instruments MMD-1 Mini-Micro Designer microcomputer, with octal keyboard and breadboarding area.

They emphasize systems that give a student an opportunity to gain an over-all appreciation of the microprocessor and microcomputer with little or no tutorial help other than the texts supplied.

Microcomputer trainers are turning up at all levels of education from high school and vocational school to graduate school. They are being used as demonstrators in formal lectures, as bench equipment in computer science and electronics laboratory courses and as the central hardware in informal two- to five-day accelerated "crash" courses sponsored by professional societies, semiconductor manufacturers and distributors and the educational systems makers themselves.

E & L Instruments is one of the equipment manufacturers that has responded to the educational crisis brought on by the onrush of the microprocessor into contemporary technology.

They are forerunners of a "hands on" approach to learning computing and are themselves evolving techniques that support this approach. The "hands on" approach makes drastic gains as its students realize it is successful where traditional courses have failed. E & L evolved two teaching techniques, first with texts that were self-instructive to the training kits, then intensive seminars that followed the guidelines of the texts but offered help and encouragement that a beginner might need, lacking confidence to learn to use a microprocessor by a book alone, and that an advanced user could utilize to increase his or her programming sophistication.

It offers the "Bugbooks" that can be used for effective primary training in digital electronics for persons lacking a formal background in electronics engineering, with a series covering logic and memory experiments using TTL integrated circuits, the universal asynchronous receiver transmitter and microcomputer interfacing. The latest series of 'Bugbooks" integrates the subjects of digital electronics, microcomputer interfacing, and microcomputer programming into a single unified course. This approach in itself is innovative, especially in view of the fact that the books are self-instructional.

The seminars are usually two to five days in length and generally have as their objectives:

Microcomputer trainers are turning up at all levels of education from high school and vocational school to graduate school.

1. The introduction of the student to the concept of a software-based electronic circuit through actual "hands on" experience with a well-know MPU chip set:

2. The attainment of a comprehension level of the language and literature of computers and programming that will permit the student to progress to writing simple programs on his own and be able to understand the specifications and instructions that accompany various factory-assembled prototyping boards.

The course presentation usually assumes some knowledge of digital electronics, but it skips over many of the fundamental concepts and theories so that the student can attain overall comprehension in the shortest possible time. The student is left to fill in fundamental knowledge, or study advanced texts as befits his individual needs.

These "crash" courses are not substitutes for more formal learning although they are pointing the way toward revision and rearrangement of the order in which the subject matter is presented in formal technical courses.

Some educators see the validity of introducing microcomputer training into programming and data-processing courses so that persons specializing in the field will have a better comprehension of the role of hardware, a subject now treated rather superficially in those specialized courses.

The public is anxious to learn to use computers, and microprocessors offer an expedient means of doing just that. A few manufacturers, like E & L, are responding to the demand, as are a few universities, with "hands-on" seminars, and the impact of their success will have far-reaching effects on how technical education will be taught in a technological future. ●

The World In Your Own Notebook

John Lees

> Imagine having your own self-contained knowledge manipulator in a portable package the size and shape of an ordinary notebook. Suppose it had enough power to outrace your senses of sight and hearing, enough capacity to store for later retrieval thousands of page-equivalents of reference material, poems, letters, recipes, records, drawings, animations, musical scores, waveforms, dynamic simulations, and anything else you would like to remember and change.

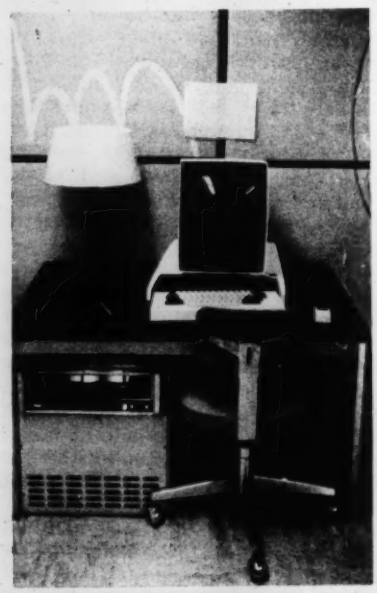
Such flights of imagination are what one would expect to find as the basis for a well-written science- fiction novel, or perhaps as the musings of a Creative Computerist wishing she could carry the school computer system to the park and use the text-editing facilities to write poetry while sitting under a tree. It isn't often that such an idea is the basis for a serious research effort by a major company, in this case the Learning Research Group of the Xerox Palo Alto Research Center (PARC), which recently released its latest report on Personal Dynamic Media—the Dynabook.

Actually, Alan Kay's original draft note (August, 1972), suggesting that PARC conduct research into the effects of personal dynamic media, did begin with the rejoinder that it should be read as science fiction. This was appropriate caution, since the newly marketed Hewlett Packard HP-35 was just then giving a first glimpse into how quickly miniaturization would put large amounts of data-handling ability into very tiny packages, and it was still two years before MITS announced the Altair. So one might very well think of the research on Dynabook as being applied science fiction; the investigation of a plausible "what if."

The Learning Research Group at PARC sees in the power of computing the ability to provide a new kind of media. Until now, all media have been essentially passive. Newspapers, books, films, radio, television: all are media forms which one may watch, but not interact with, not participate in on an individual basis. The few specialized exceptions to this, coloring books, primitive computer time-sharing systems, etc., have been limited at best. What was desired was a flexible, dynamic, active, personal medium which could help a person to learn about, interpret, and interact with the world.

So a new technological device was designed; a device not yet possible to manufacture but within the reach of present technology: "The size should be no larger than a notebook; weight less than 4 lbs.; the visual display should be able to present at least 4000 *print-*

Cardboard mockup of a Dynabook



An interim Dynabook

Some of the fonts possible

wun dai when poo barr had nuthig els too doo, her jhast he wud doo stumphig, see hee went round too piglet's hous too see whut piglet wuz dooig. it wuz still snoeig as hee stumpt avver the whiet fierest track, and hee ekspected to fiend piglet weerneig his tarz in frunt uv his fier, but too his surpries hee saw that the frunt dier wuz open, and the meer hee lukt insied the meer piglet wuzn't thair.

"hee's out," sed poo sadly. "that's whut it is. hee's not in. ie jhall hav too go a fast thigkig wauk bie mieself. bother!"

but first hee jhast that hee wud nock very loudly just too mark kwiet jhuar...and whiel hee waeted fer piglet not too anser. hee jumpt up and doun too keep weerm, and a hum caem suddenly intoo his hed, which seemd too him a gud hum, sujh as it hummd heepfully too uthers.

ITA

भाग १
अम्बा
विनी-पु तथा अन्य मरीहरु हाम्लाई
बोलाइने छन, र कथा सुरु भैहाल्छ।

यहाँ चाहि क्रष्टोफर रामको पछाडि, ढेक, ढेक, ढेक, टाउकोमा अडेको बाल् बहादुर बाघिबाट अडेर रहेछ। अरू धन्याबाद आउने गितो उस्लाई चाहा नभएता पनि, कहिले कहिं उस्लाई लाग्छ कि यदि यो चाहि ढेक-ढेक-ढेक खतम हुन्छ र उ सोच्न सक्छ भने अरू आउने गितो हुने छ। अनि लाग्छ कि छैन। तापनि, यहां तल अहएसेर विनी-पु बोलाइने छ।

उस्को नाम पहिल्यां पटक सुनेर तिक्काई भन्न लाग्ने उस्ले भेले भने, "तर बताई साम्यो कि उ केता हो ?।"

"हो--बताई पनि त्यसो लाग्यो," क्रष्टोफर रामले भन्यो।

"त्यस कारण उ केता भए उस्को नाम 'विनी ' हुन सक्दैन। होइन त ?

"हो---"

Sanskrit

ing quality characters with contrast ratios approaching that of a book; dynamic graphics of reasonable quality should be possible; there should be removable local file storage of at least one million characters (about 500 ordinary book pages) traded off against several hours of audio (voice/music) files." It is envisioned that a Dynabook will cost about $500, which should be inexpensive enough for school systems to supply Dynabooks free to their students, since textbooks would be replaced by Dynabook removable files.

Since this ideal is not yet technologically possible, the Dynabook is being implemented with existent hardware, refered to as interim Dynabooks, so that the effect of the Dynabook concept on learning and education can be studied. The interim Dynabooks meet essentially all of the hardware objectives except size and cost and they provide the opportunity to develop the all-important software for Dynabook. Given the present state of the art, software development is much more difficult and time-consuming than hardware development. Dynabook will eventually be put together from more or less "off the shelf" hardware components, but the software which will give life to the concept must go through a long and arduous process of development if it is to aid and not hinder the goals of a personal dynamic medium.

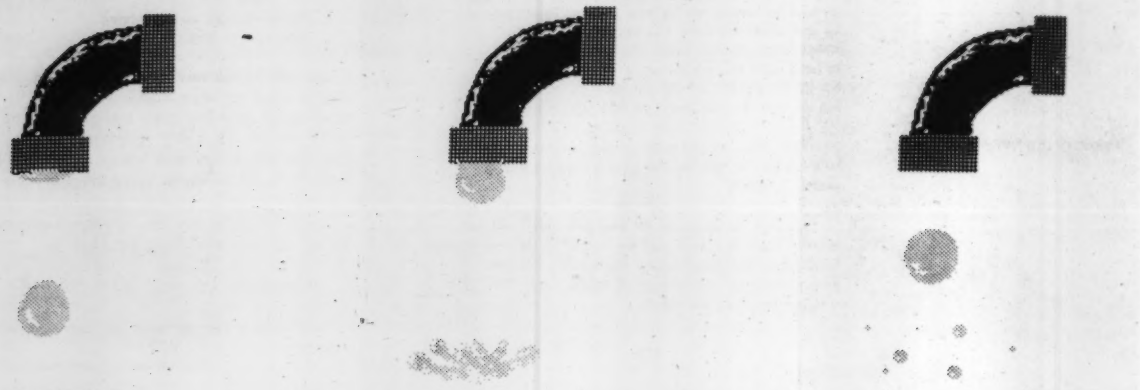
The software system being developed for Dynabook is known as Smalltalk and its capabilities are truly amazing. [See "Learning About Smalltalk," Sep-Oct 1975 and "A Smalltalk Airplane Simulation," Mar-Apr 1976 *Creative Computing*.] With the graphic capabilities of an 8½ by 11″ display composed of over one million points, some really fantastic things are possible, from the planned book-quality printing in any desired font up to animated cartoons, musical scores that can control a synthesizer, all manner of simulations, the ability to "paint" on the display as if it were a canvas, and just about anything else an imaginative person can think of!

Smalltalk is a very powerful yet easy-to-use language which deals with objects in process. The idea is that "simple things should be *very* simple (while not constraining later expert use) and complex things should be *very* possible." Rest assured that Smalltalk is like nothing you've every seen before! Implemented at present only on the interim Dynabooks, Smalltalk itself is going to cause an upheavel when it gets out into the world.

So there you have it; a short introduction to an idea which may change your world. Dynabook could very easily be a reality by the end of this century. It isn't too far-fetched to say that the much touted "computer age" will truly have arrived when something such as the Dynabook becomes common. At the present time computers have not so much changed our lives as they have made it possible for existing institutions to continue to exist in a rapidly expanding world. Banks, for instance, would have become impossible ten years ago without the aid of computers, but only now with the first uses of Electronic Funds Transfer systems is the basic character of the institution of banking beginning to change.

The Dynabook concept has the potential to affect in a very basic way a great number of our society's institutions. The impact of the next new medium, Dynabook, could be earthshaking.

Look at what will be affected by widespread use of Dynabooks and particularly by widespread use of Dynabooks in networks, via phone lines or cable television systems. For *correspondence* (and the postal system)—the Dynabook has all the capabilities of a typewriter in a smaller, more versatile package, and can send and receive letters in addition. In *publishing*, Dynabook is a personal printing press. Your textbooks can be a memory file, your family can receive its newspapers on a reusable file, its monthly magazines on another reusable file. Forests will have a chance to



Dripping faucet

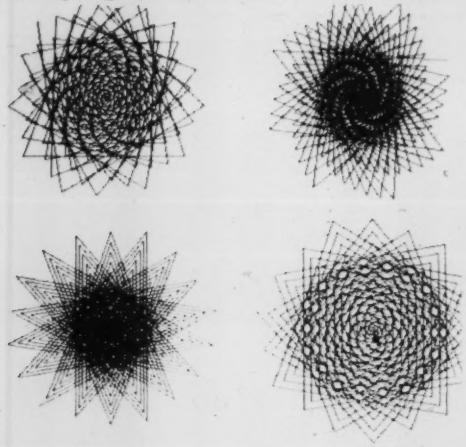
grow again! Someday you will be able to access the Library of Congress by plugging into a network. In *education,* the new learning activities possible are boundless, and they will depend less and less on dedicated school facilities. As for *calculators, televisions, radios,* all would face a very stiff challenge. Television in particular would be in for trouble—who's going to watch poor television programs if they can link up with all the other kids on the block for a game of really super Startrek or Startrader? The possibilities boggle the imagination!

It's all been said before, you say. People are always saying great things will come of computers and nothing ever happens. Bah, humbug!

Oh, yeh? Don't forget we're talking about *personal* computing, not about a monster machine somewhere with terminals all over the place. That's the difference. Look what happened with hand-held calculators. The same thing could happen with Dynabook. The important thing to realize is that Dynabook would be *distributed computing* with *centralized information.* The cost of making information and knowledge available is going up fast. In that climate, distributed hardware and centralized information make worlds of sense. Programming is expensive. Let each individual do the programming!

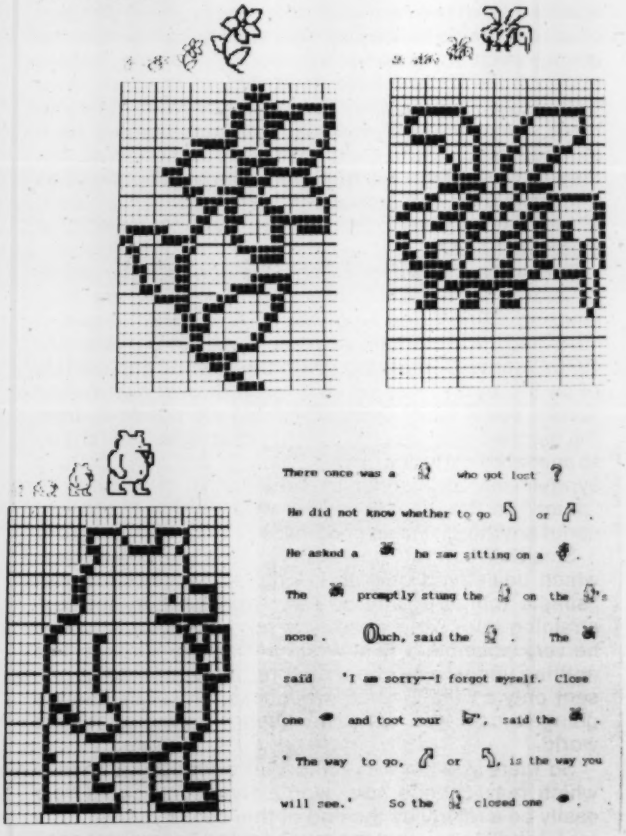
Maybe Dynabook is just a dream. I certainly hope not. Many's the time I've wished I could wander around or go sit under a tree with the book I'm reading and a sketchpad and a typewriter but haven't done so because I didn't want to pull a wagon. Maybe someday I'll be able to just pick up my Dynabook and walk out the door. It sure would be nice. I'll keep on hoping; some dreams do come true. ●

Thanks to PARC for permission to use quotes and photographs.



```
Dpoint mx my!
Dsee 0 110!
Dpoint mx my. see 0 134!
Dpoint mx my. see 0 140!
Dpoint mx my. see 0 100!
D
```

Example of Smalltalk


There once was a who got lost ?
He did not know whether to go or .
He asked a he saw sitting on a .
The promptly stung the on the 's
nose . Ouch, said the . The
said 'I am sorry--I forgot myself. Close
one and toot your , said the .
' The way to go, or , is the way you
will see.' So the closed one .

Telling a story with pictures

PILOT

Gregory Yob*

PILOT is a dialog-oriented interactive language for use by teachers and students on small systems. Its simple syntax and free format encourage innovation and use by those frightened by computers or who lack time to learn a more complex language.

PILOT—A TOOL TEACHERS CAN USE

One of the hidden factors in introducing new technology to the classroom is its demands upon the teachers. A teacher's time is quite limited as it is (with state requirements, meetings, etc.) and any new technology or methods should increase the net time for teaching.

Bringing the computer to the classroom usually complicates matters. A typical CAI system forces the teacher either to learn a complex language or a fixed and complex curriculum package. In both cases, the time required for skillful use of the computer is usually too great for effective utilization.

The usual result is that skilled programmers prepare vast and inflexible curricula which are then given to the teacher. This is horribly expensive and inefficient. What is needed is a means of generating materials immediately, quickly and simply for the day-to-day requirements of the teacher. The tool must appear "natural"; that is, it must look like natural-language dialogues; it must allow for variations of style, nuance and tempo; it must appear riduculously simple; that is, be "learnable" in less than an hour. It must avoid the computeristic scientific bias which separates the math/sciences from the English/humanities areas of teaching.

The PILOT language is the beginning of such a tool. Its basic four functions (T: to type text; A: to receive an answer; M: match keyword; J: jump) can be taught to nearly anybody in ½ hour. this includes persons who just won't (can't) understand math and stuff like that.

*Gregory Yob is an author of several versions of PILOT and has participated in the definition of the language. He currently coordinates the PILOT Information Exchange, a national user's group for PILOT. Other areas of interest include computer games and working with neighborhood computer centers.

PILOT programs are written as simulated dialogues in English (or Spanish or... .) and can be entered and executed quickly. Brief programs for special purposes are easy to do and since the teacher is doing it, not the curriculum designer, the program is just as easily changed or discarded.

The dialog format of PILOT also allows immediate understanding of PILOT programs, making them highly exchangeable with other teachers, and encouraging the dissemination of good ideas. This is in contrast to most other computer languages, which require a detailed description of the program as well as the code.

These features make PILOT a viable and non-time-consuming tool for teachers using computers in education.

HISTORY OF PILOT

PILOT was developed in 1969 at the University of California Medical Center by John Starkweather to meet some instructional needs. It was used to train students in pharmacology and later in an elementary school in Marin county. Stanford Research Institute used PILOT in an experimental educational research project (with very good results) and later developed a dialect, Called PYLON, which was a very simplified version. In 1971 and 1972, other variants of PYLON were developed by Stanford University, The California State College computer network and Lawrence Hall of Science at the University of California, Berkeley. A small version of PILOT was made by John Starkweather for stand-alone operation on the Datapoint 2200.

In January, 1973, the varied users of PILOT and PYLON met to standardize the language. A standard "core" version was agreed upon, called PILOT 73. The "core" version includes standards for extension as each user is free to make his PILOT more powerful for his system.

Currently, PILOT is implemented in about a dozen languages on 20 or so systems. There are 25-30 sites actively using PILOT nationally at present. A user's group, called "The PILOT Information Exchange," dissem-

inates information and initiates contact among those interested in this language.

THE RELATIONS OF PILOT TO OTHER LANGUAGES

The thrust of computers in education seems to be mostly in these areas: First, courses designed to teach about computers, how they function, and how to program them. Second, using the computer to pass curricula or other study materials to the student. Third, actively involving the students in using the computer to solve problems in their course of study. fourth, allowing students to use the computer for their own expression, self-integration and growth.

Each of these areas have languages associated with them. FORTRAN, assembly language, COBOL and BASIC are taught with courses concerned with how to use and understand the computer. COURSEWRITER, LYDIA, TUTOR and PILOT are used to pass courses of study. Most problem-solving is done in BASIC with small efforts in FORTRAN, LOGO, and SMALLTALK. PILOT and LOGO are often used for self-expression and growth.

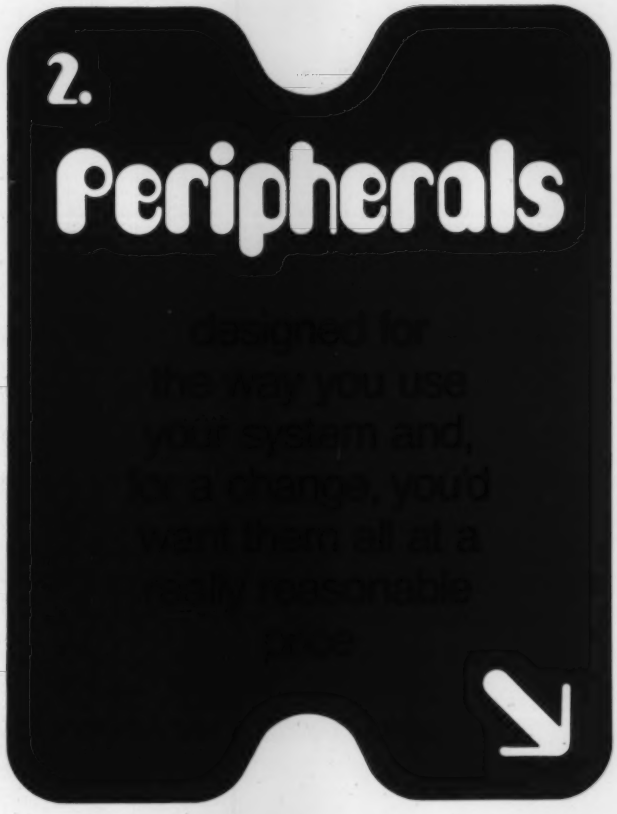
That's how PILOT fits into the general picture. A closer look at four languages will give a sharper focus:

COURSEWRITER is designed for presenting course material to a student. The teacher, or more often, the curriculum developer, is expected to write series of lessons, tests of the student's progress, etc. The student is exposed to the material being taught, and NOT the language. Unfortunately, (if you ignore the salesmen), COURSEWRITER is too complex and inflexible for most teachers to use effectively, which leaves the development of materials in the hands of specialists. As teachers are unable to provide feedback, the proffered courseware packages lack vitality and are often little more than mechanized textbooks.

BASIC is in essence FORTRAN with a lot of garbage removed. Its ready availability on small systems (especially timesharing systems) makes it quite popular for math and science teachers. The student learns BASIC as a tool for solving numerical problems posed in his courses. However, BASIC is very weak with strings and words. The humanities staff has never heard of BASIC and even BASIC's relatively simple syntax is too difficult for the word- and English-oriented person. The result is that BASIC users tend to be in the scientific and technical disciplines.

LOGO (like BASIC vs FORTRAN) is a simplified variation of LISP with control of devices other than the Teletype—such as the "Turtle," a plotter-robot or "Music box," a tone generator. LOGO is self-extensive and capable of handling lists and recursive function calls. LOGO is excellent for problems concerning the order and arrangements of things—procedures rather than calculations. At present there are few users of LOGO and they are mainly math- and computer-oriented.

PILOT is a dialog-oriented language which deals mainly with words and text, The syntax is extremely simple, allowing teachers and students to learn it readily. Because much educational material is essentially in English, non-mathematical users find PILOT a flexible tool for presenting materials via the computer. PILOT lacks arbitrary conventions such as "Frames" (viz IDF)* and counters on every answer by the student which are



often unnecessary and hamper the style of the program author.

It is clear that PILOT will not and is not intended to replace the other languages used in educational applications. It fills a complimentary place among dialog, numerical, procedural, and curricular languages.

THE PILOT LANGUAGE

Now for the part you have all been waiting for—what does PILOT look like? Here is a very brief introduction to PILOT. Contact the Exchange for a more detailed description. This program almost teaches you the language—see if you can figure it out first.

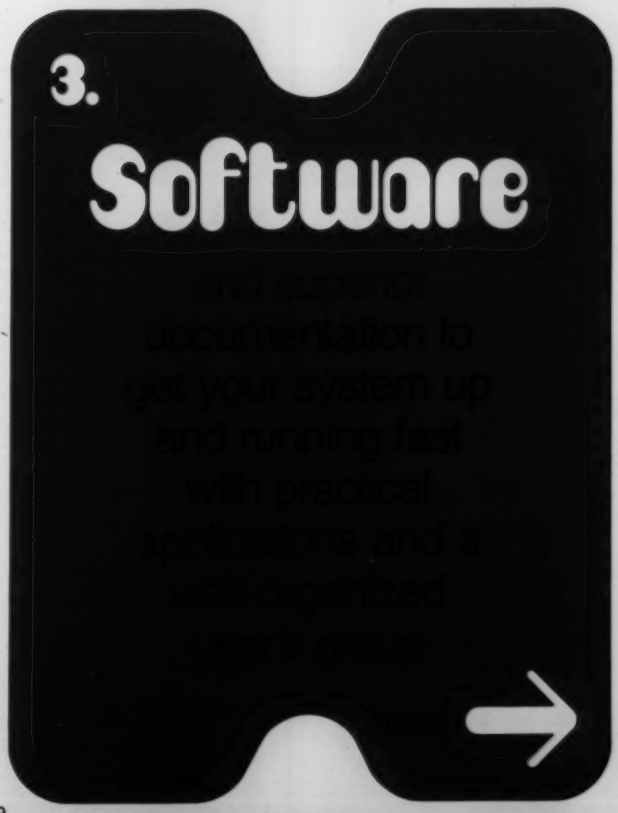
```
    T:Hi there. Is this your first time on a computer?
    A:
    M:yes,sure,ok,yeah
    TY:I hope you will enjoy your experience with me.
    T:In the area of education, what are your main in-
     :terests?
*MORE   A:
    M:teach,instr,learn,material
    JY:*TEACHING
    M:admin,program,test,grad,analys,course,curr
    JY:*OTHER
    T:Please tell me more about this.
    JN:*MORE
*TEACHING T:An excellent way of using computers for
teaching and learning
     :is to give children an opportunity to write their
     :own programs.
     :How does this strike you?
     A:
     M:good,excel,fine,yes,important
     TN:I see that you disagree. Will you explain fur-
     :ther?
     JY:*YES
     A:
*YES T: Of course the teacher should write programs
too. However,
     :it isn't always necessary to use "packaged cur-
     :ricula" for effective use of
     :the computer in learning situations.
     E:
*OTHER T: Are you interested in the computer's ap-
plication to teaching?
     A:
     M:no,never
     JN:*TEACHING
     T:Then perhaps PILOT is not for you. PILOT's in-
     :tention is for its use by teachers
     :and children for interactive dialogues. Thank you
     for your time and interest.
     E:
```

A look at this program shows four basic kinds of statements:

T: This means to type out the text following the colon (:).

A: Here the computer stops and awaits a reply by the user. Answers may be saved for later use in T: statements by following with a $-variable. Here is an example:

```
T:Who are you?
```



*Hewlett-Packard's CAI "language."

A:$NAME
T:OK, $NAME, I have a puzzle for you.

M: The last reply is examined for the keywords in the list following the colon. If there is a "Match," any statements with the Y (like TY:) will be executed. In the case of no match, the N-suffixed statements execute.

J. Jumps to any part of a program are possible. Branching is essential for differing presentations according to answers given. The *label is a tag indicating where to go. JY and JN are often used to vary branching on replies.

Successive applications of the M: can perform precise analysis of an answer. M: also allows the search of words, suffixes, prefixes and text fragments by allowing the blank as a legal match character.

Once a M: is executed, the yes or no (Y or N) is effective for any statements with the respective suffixes. Statements lacking Y or N will always execute.

The ability to save answers allows the simulation of intimacy and personality by careful use of echoing. Amusing stories, poetry, etc. are possible in this manner. The personal-seeming responses are very important for the captivation of interest.

Some more advanced statement types are:

R: Remarks for documentation

C: Perform computation (usually in host language, like BASIC)

U. Call a subroutine tagged by a *label

E: Return from a subroutine or program end.

A:#letter Allows numerical variables which can be modified in C: and presented in T: in a manner similar to $variables.

4. Self-Instruction Courses

PILOT has protocols for extensions peculiar to the system it is running on. For example, a useful extension may be:

SCREEN:UP 5

This would move the cursor up five lines on an alphanumeric CRT with cursor control characters.

When PILOT is implemented in a higher level language, such extensions are easily made.

This extremely simple syntax and consistent form lets the program writer concentrate on the quality of the dialogue and important branches rather than the picky details of syntactic form. PILOT is very rugged and can tolerate sloppy code which is encouraging to the beginner. Very elegant and complex programs may be written if needed.

GETTING PILOT ON YOUR SYSTEM EFFECTIVELY

Getting PILOT really running on your system requires more than the language processor.

This section describes an ideal which is seldom met in practice. The author notes that the successful users of PILOT usually do most of the following, sooner or later.

SOFTWARE

It is an illusion that having PILOT will do it all for you. There are systems in which loading a program is harder than mastering the language it is written in!!

PILOT. Obviously you must have some kind of PILOT. If you have a choice of versions (as many do), points to look at include: speed and response time, use of mass

5. Service

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real help if you need it

storage—efficiency and number of accesses, completeness of PILOT 73 (the standard version), the ability to tolerate badly written programs or at least to try hard at running them, idiot-proofing (no way to crash the program or system, even intentionally), clear concise error messages, availability of documentation and technical help.

EDITOR. Somehow the PILOT programs must get into the machine, saved and changed. At text editor is often used for this, though some versions of PILOT include an editor/syntax checker. Beware!! Recently at San Francisco State University, the system's text editor was so very complex that the PILOT was never used. The problem was cured by writing an editor especially for the PILOT. There is no point to a language simpler than its editor!!

The trend in PILOT editors is to emulate the BASIC line-by-line editor. This is usually wise, as many PILOT users will go on to BASIC or vice versa. The editors which use pointers have been hard to teach to children using PILOT. The eventual cure is to have a full graphics system with joystick or mouse for editing. (May the day come soon.)

TUTORIAL OF PILOT. As PILOT is an instructional language, apply recursion and use PILOT to teach PILOT to new users. Many new users will prefer to learn at the terminal, so writing this package is a good checkout of the system and teaches PILOT to that first group of users.

A good tutorial is a system in itself, and these features may be included. (A) Help and summary information. Who to call in distress, A list of editor commands, a list of PILOT statements, a list of options within the tutorial system. (B) The PILOT tutorial set of programs with a reference page or two for the experienced user (C) The editor tutorial—don't forget this one! (D) How to use the %¢&&% terminal.

They're the ones you've been waiting for.

6. Assembly Manuals

The seed library can be very helpful in setting the style and mood of PILOT's use. Many teachers will refer to the seed programs as models for their teaching work. Without this stimulus, the teachers will fall back on their preconceptions of computer-based teaching, resulting in the dull boring drill or curricular approach to PILOT. A PILOT user submitted to the Exchange some very long programs which were entirely questions and multiple-choice answers—having never seen a light, fun PILOT program. This point cannot be overstressed. Without new models, old ones prevail, despite their inappropriateness for current needs.

To summarize: the PILOT language, the Editor, the PILOT tutorial system, the Seed programs, are all important software.

REQUIRED DOCUMENTATION

Many of these follow closely the items mentioned in the software section. The only effective way to make documentation is to insist on it BEFORE anything else. Documentation is almost always done after the fact, with parts missing and a generally reluctant attitude. Good luck!!

PILOT LANGUAGE. The usual technical documentation is a must if any changes are to be made: the program listing, flowchart, detailed operational description, file-handling methods, modifications, extensions beyond PILOT 73, etc. It must be clear enough so a programmer not familiar with the system can make changes without rewriting the whole thing.

EDITOR DOCUMENT. See above and repeat.

PILOT TUTORIAL. As this is in PILOT, a listing and chart indicating the main branches is sufficient.

USER'S MANUAL. This is perhaps the most important document. A new user should be able to learn PILOT with the manual and a terminal. Any good manual has these three levels: (1) How to do the mechanics, such as logon and type "return." (2) How to use PILOT and the Editor. (3) Advanced things and neat tricks for a user with some experience.

THE SEED PROGRAMS GUIDE. More than an index, this document gives brief summaries of each seed program and its intent. At a later time this simple guide can grow into a comprehensive manual of techniques for teachers. An accompanying document provides the listings.

IMPORTANT PEOPLE

The people involved in your PILOT project are very important for its growth. Here are a few roles—usually different persons fill each one as the styles differ in each case:

THE PROGRAMMER. This fellow (person) gets the PILOT language, the editor and some other software running. He knows all its quirks and is the sole source of help when it's bug-fixing or upgrade time.

THE WRITER. He/she writes the manual and other documentation for users. This person does not care much for the details of the system...just how it can be used. The motivation is to give a clear, simple presentation to the user.

THE TEACHER OF TEACHERS. Here the motivation is towards teaching instructors how to use PILOT for their applications. This person MUST appreciate the biases and viewpoints of the naive beginner. Especially those about the computer—how it is impersonal, etc. Patience and a winning personality are crucial for this role.

THE COLLECTOR. This person is interested in finding and making available interesting PILOT programs, manuals, etc. He will grow a system library of PILOT programs and improve the collection of seed programs. Good taste and a librarian's sense are important here.

The last three roles are often ignored by the programmer or else the computer-center staff thinks it can do it effectively. This is rarely the case and the staff should welcome those who do become attached to these roles.

Too often good systems are represented by those who have little conception of the human needs of the users. PILOT really requires the right people for innovation and active usage. You can easily imagine the alternative.

OTHER RESOURCES

To paraphrase—good systems do not grow alone. A local user's group should meet from time to time for sharing and management of the PILOT system. Contact with other installations greatly increases scope and fertility. In summary, you need more than the processor for smooth and rapid implementation of PILOT on your system. Take heed.

ACCESS TO INFORMATION

At present there is very little in print regarding PILOT. The PILOT Information Exchange has a newsletter with indexes to implementations, users, seed programs, manuals, technical specifications and applications articles, and a library of unpublished PILOT materials. PILOT materials are available for the cost of copying. (The PILOT Information Exchange, c/o Loop Center, 8099 La Plaza, Cotati, Calif. 45628.)

SOME VIEWPOINTS TOWARDS PILOT

OVERCOMING FEAR OF COMPUTERS

The public's image of the computer is highly negative: computers are tireless malevolent malicious beings whose intent is to build a sterile anti-human world. Humans are to be manipulated, bent, folded and spindled to the arbitrary whims of the machine-god, according to this view.

The fault, of course, lies not in the machinery but in the programming and the institutions which use computers. It is always "computer errors" or "go see the computer" rather than specific human beings.

In the LOOP center, a storefront computer center open to the public, some common reactions are: "Computers intrigue me, but I am afraid of them." "Can I ask the computer questions and get answers about anything?" To overcome these biases requires both patient and human-oriented people to tend the initial man-machine interaction between the shy user and the computer. Also vitally important is the software's capacity to respond lightly and humorously and "humanly" rather than mechanically.

Human beings usually communicate via dialogues made of words. Most computer languages are ill-equipped to handle words.

PILOT is a simple language which is entirely word and dialog-oriented. It is far easier to write a simulated dialog in PILOT than in other languages. This includes languages such as COURSEWRITER, which are designed for educational uses.

PILOT has several features which aid the creation of dialogs. It has a minimum of the syntax that confuses the word-oriented human program writer. PILOT has a powerful word-matching function which identifies likely keywords in anticipated responses. Another feature is the capacity to echo selected responses at later points in a dialog. This simple feature vastly personalizes and increases the intimacy of a dialog. (For example, the reply to "What's your name?" can appear elsewhere.)

Overcoming the public's fear of computers will take a long time. Individually responsive dialogs such as those possible with PILOT will help.

WHY KIDS SHOULD WRITE IN PILOT—A HIDDEN RESOURCE

The standard educational computer system has only two goals. One, teach the material; two, watch the students. The approach definitely limits the student's role to the traditional one of a semi-sentinent sponge.

Yet—let the student actually program the machine, and WATCH OUT!!! If it is a BASIC system, half a dozen games will suddenly sprout and get intensive use. (Has anyone noticed that these games never seem to fill any particular educational need, yet use sophisticated concepts for irrelevant purposes?? A statement of educational value.)

PILOT is especially designed for student use. PILOT's simple form is easily learned by 10-year-olds. Kids will be writing short programs in a day or two—the wise teacher can use this property to great benefit. Here is a short guide:

Traditionally, the purpose of the essay question in tests is to see if the student can express his knowledge clearly and concisely. If he can, it's a good assumption he knows not only the material but also how it is organized. This principle can obviously be extended to the creation of a clear teaching program to illustrate the points of understanding.

It is easy to take advantage of this idea in PILOT. Give a few example programs which clearly teach a simple idea and set the students to writing little PILOT tutorials on whatever subjects. Some of the programs will be good and a few excellent. Let the entire class interact with these. The students will share each others programs with mutual critiques and a synergistic learning process starts. In this way, a teacher's role changes from materials spoon-feeder to that of mentor.

A subtlety of this method is the language, style and tempo of the student-created material will often communicate a subject more effectively than one written by adults. Children of different ages use language differently and this will be reflected in the programs. Also, ethnic differences can be taken into account.

You may note that this is heresy: students can be an educational resource of enormous value. PILOT is one of the few languages which can tap this resource.

THE ROLE OF FLUIDITY, MUTABILITY AND CHANGE

All too often the computer destined for education gets waylaid by the idea that "Once we have it programmed right, it will teach all the courses for us." The whole notion is that an initial large-scale investment of time and money will yield lasting long-term savings.

The catch to all this, of course, lies in the time required to get that first system completed. Inevitably it is in the range of several months to a few years, and somehow, the system never is really ready. A moment's thought will show why. First, the external requirements, such as state rules, budget changes, staff changes and so forth, change during the initial period—usually forcing corresponding changes in the computer-based curriculum under development. Also, the teachers and courseware authors are making improvements (?) to their product.

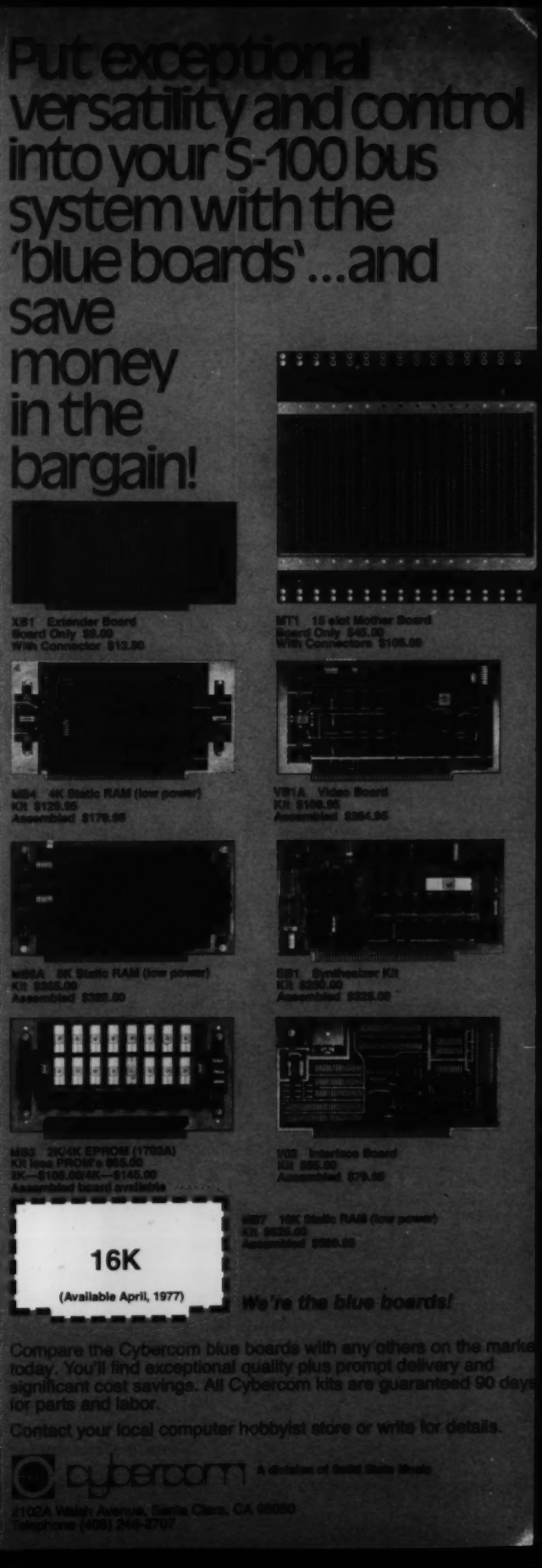
PILOT offers a different approach to this problem. Why have a large system of courses built by a few experts to fill every need? It can't be done and costs too much. There are more educational computers running BASIC than there are running large CAI systems.... As with BASIC, PILOT programs may have a very short lifetime (such as hours or days) and yet can be extremely useful in teaching.

Programs with a short lifetime encourage experimentation and novel approaches. If it doesn't work, throw it away and try something new. If it does work, improve it or save it for later. Most important, the teacher and students can make these choices without fear of a negative evaluation from higher authority. No curriculum committees and month-to month haggling is required before a new idea can be tried.

Ephemeral PILOT programs are also light in tone and mood—that is, they aren't "serious" or necessarily yoked to some vast task. Any creative student knows the importance of lightness and triviality in true teaching.

SUMMARY

I hope these remarks have given you a taste of PILOT's flavor and usage in an educational context. PILOT fills an important space in the area of word-oriented, student-authored programs. It is intended as a classroom tool for teachers not especially oriented toward computers and is not specifically aimed at curriculum-makers. PILOT's simplicity is a great aid for the computer-reluctant or time-short person. The four mnemonic instructions, TAMJ, allow effective programs to be written immediately. ●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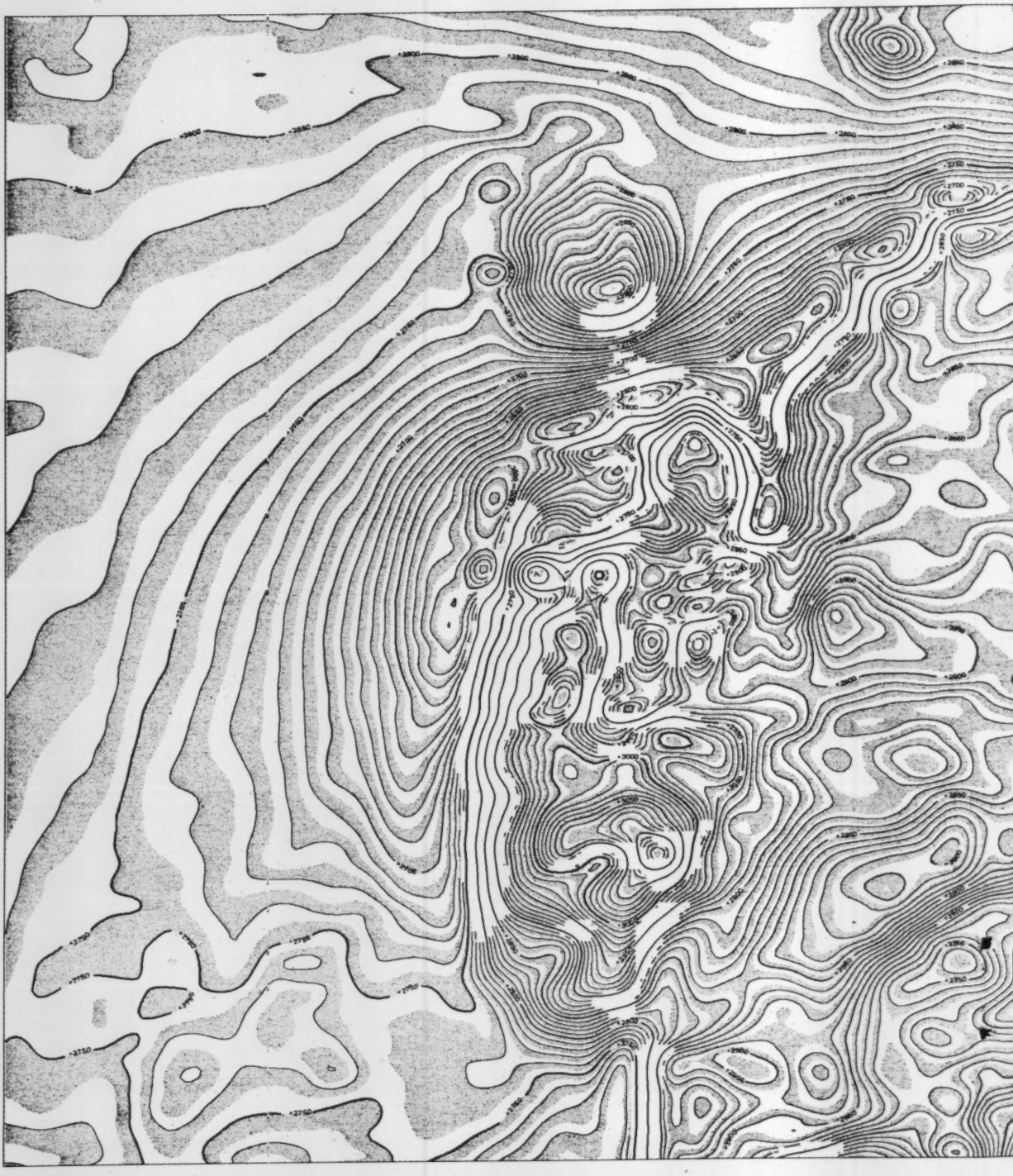

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COMPUTER RECREATIONS

Dennie Van Tassel

Bust Your Compiler

Many commands within your compiler have limitations. These limits are usually so large that you will seldom encounter them. For example, one popular compiler will allow about 400 parentheses in *one* statement before objecting. An interesting exercise is to find other limitations on your favorite compiler. Here are some suggestions:

(a) Maximum number of parentheses in one statement.
(b) Maximum size of a 1-dimensional array. Maximum dimensions of an array.
(c) Maximum length of literal or bit constant.
(d) Maximum length of a single statement.
(e) Maximum length comment or maximum number of consecutive comments.
(f) Maximum number of nested DO or FOR loops (or blocks or IF THEN ELSE).
(g) Maximum number of subroutines (or nested calls to subroutines).
(h) Maximum number of arguments in a subroutine.
(i) Maximum number of recursive calls.

Can you think of any other restrictions of this type? Hint: Try examining the list of error messages for your language compiler.

Self-Reproducing Program Revisited

I received many solutions for this problem. For those of you that may have missed it in the Sep/Oct 1976 issue, here is the problem: Write a program that prints an exact copy of itself. No input statements are allowed.

Several people sent in solutions where they used the file the program was in or they created a file before hand, and then read the file. But this violated the rule that no input statements were allowed. Also there were several solutions sent in that required over a page of code.

Here are three good solutions, one in BASIC and two in FORTRAN. No COBOL solution was sent in, even though it is fairly easy in COBOL. It seems it should be possible to write a shorter BASIC version, but the solution is pretty good.

Basic solution by Donald Bell, a student at California State University at Fullerton.

```
10 DATA "B$="DATA "+CHR$(34)
20 DATA "FØR J=10 TØ 180 STEP 10
30 DATA "READ A$
40 DATA "PRINT J;B$;A$
50 DATA "IF J<>90 THEN 170
60 DATA "RESTØRE
70 DATA "B$=""
80 DATA "NEXT J
90 DATA "END
100 B$="DATA "+CHR$(34)
110 FØR J=10 TØ 180 STEP 10
120 READ A$
130 PRINT J;B$;A$
140 IF J<>90 THEN 170
150 RESTØRE
160 B$=""
170 NEXT J
180 END
```

Fortran solution by Mark Barnett at Stanford University.

```
      REAL*8F(6)/48H(7X'REAL*8F(6)/48H'6A8,1H//7X'PRINTF,F'/7X'END')/
      PRINTF,F
      END
```

Fortran solution by Armond O. Friend of Brookline, Mass., a Freshman at MIT.

```
      WRITE(6,100)
      CALL EXIT
  100  FØRMAT(T7,12HWRITE(6,100)/T7,9HCALL EXIT/
     12(48H 100   FØRMAT(T7,12HWRITE(6,100)/T7,9HCALL EXIT/
     1/T6,6H12(48H),T69,2H)/,T7,2(31H/T6,6H12(48H),T69,2H)/,T7,2(31H)/
     1T62,11H)/T7,3HEND),T6,2(28H1T62,11H)/T7,3HEND),T6,2(28H)/T7,3HEND)
      END
```

Run Times — The Most Important Variable is the Human Factor

78 multiplied by 345 equals 26910. Notice that these three numbers have between them all of the digits 0 to 9 occurring just once. Can you write a computer program to find all such combinations?

In the Jan-Feb 1975 issue of *Creative Computing*, we posed a problem to find all of the combinations of a 2-digit number multiplied by a 3-digit number equaling a 5-digit number which used all ten integers 0 to 9. (There are nine solutions.)

Geoffrey Chase, OSB, of the Portsmouth Abbey School in Rhode Island wrote five different programs to solve the problem on the same computer (PDP 8/e) and did an exhaustive analysis of the differences. Space does not permit us to print his entire discussion or the programs; however, the following is a brief summary.

Language	*Timing*
FORTRAN/SABR Coding, using EAE subroutines	0.9 sec
FORTRAN, no machine language patches	3.2
Compiled BASIC, using EAE	15.5
FOCAL, with some EAE floating point patches	61.5
Multi-user BASIC, no EAE	108.0

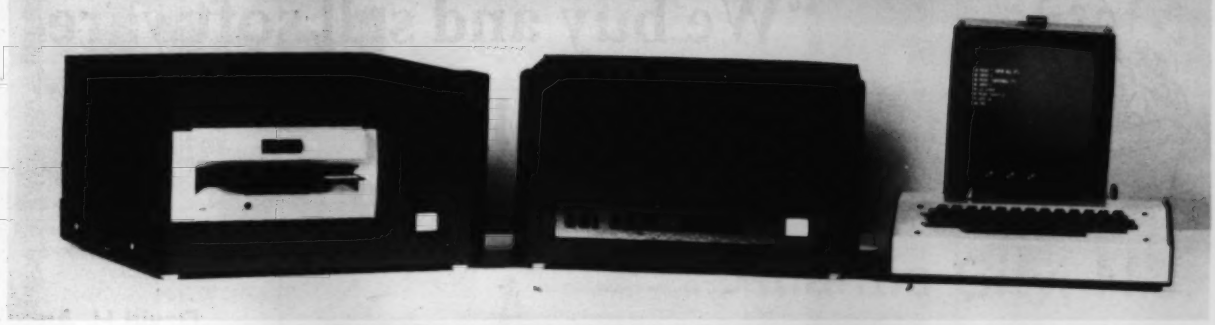
We see that there is over a 100-to-1 spread with the easy-to-program languages taking considerably longer to run. However, one must ask the question whether the ultimate goal in a particular program should be efficiency in running or efficiency in coding. To give you some grist for thought, why not try to come up with an estimate of the following ratio for your computer installation.

$$\frac{\text{Cost to Program One Line of Code}}{\text{Cost to Execute One Line of Code}} = x$$

IBM estimates that the value of x for 360 and 370 series computer installations is approximately 100 million to 1. Obviously the ratio is different for a hobbyist or student programming a dedicated micro or mini. Nevertheless, the point is that the human factor is incredibly important.

That is not to say that the computer doesn't play an important role. Next issue we'll be publishing a set of timing comparison programs in Basic and Fortran along with timings on popular minis, micros and timesharing systems so you can compare your machine to others.

INTRODUCING THE COMPLETE CHALLENGER SYSTEM.



OSI's DREAM MACHINE is a totally integrated computer system.

Imagine a system complete with terminal, CPU, memory, floppy disk, software, and all the little necessities to make it work together immediately. Now imagine this complete system available not only fully assembled, but priced much lower than anyone else's kit. What you are dreaming of is OSI's "new" Challenger System!

In the configuration shown above, the Challenger includes everything an end user needs for a complete small computer system. All you add is 110 VAC power and a desk to put it on.

This fully-assembled system includes:

HARDWARE:

OSI Challenger 65 with 16K RAM, serial interface, system monitor PROM, and floppy disk bootstrap PROM.

OSI Challenger single drive floppy disk formatted for 250K bytes storage per diskette surface.

Stand-alone terminal and Sanyo monitor for 16 lines of 64 characters at 2400 baud (other terminal options are available).

And all interconnecting cables!

SOFTWARE:

2 diskettes containing over 100,000 bytes of software including OSI's powerful Disk Operating System with variable length sectors. **6502 DISK BASED RESIDENT ASSEMBLER/EDITOR!** A totally interactive Assembler/Editor which assembles up to 600 lines a minute and is completely compatible with MOS Technology's Cross Assembler format. This program also contains a powerful disk-based line editor with commands for general text editing. **OSI'S EXTENDED MONITOR:** A powerful machine language debugging and utilities package including a Disassembler which is format compatible with the Assembler! **OSI 6502 8K BASIC FOR DISK BY MICROSOFT:** This powerful BASIC has all the features of Altair® 8K BASIC for the 8080 plus higher speed and disk storage. And it comes complete with a BASIC program library.

DOCUMENTATION AND SUPPORT:

We include over 600 pages of hardware, software, programming, and operation manuals. The Challenger is based on the well-proven OSI 400 system. The over 2,000 OSI 400s and Challengers now in use assure continuing hardware and software support for this system for years to come!

EXPANDABILITY:

The Challenger System can now be expanded to 192K of RAM and 16K of I/O and ROM. There are over 13 accessory boards including A/D, D/A, parallel and serial I/O, cassette interfaces, a dual drive floppy, a video graphics display, several RAM and PROM boards, and multiple-processor configurations.

APPLICATIONS:

The Challenger system is complete, fully assembled and configured so that the Disk Operating System can be booted in immediately on system power-up. Even a relatively inexperienced operator can have a complex BASIC program on-line just seconds after the system is turned on. The ease of use, high reliability, and large library of standard BASIC applications programs make the OSI Challenger System the first practical and affordable small computer system for small business, educational institutions, labs, and the personal computerist.

PRICES:

Challenger System, complete as stated above with terminal and monitor **$2599.00**

As above without terminal. Specify RS-232 or 20ma loop and baud rate **$2099.00**

IMPORTANT NOTE:

One of the most important features of the Challenger System is that it is not really "new". OSI has been delivering the basic circuitry of the Challenger since November 1975 and the floppy disk since June 1976. The only thing new is the total integration of the components as a complete, simple to use, fully-assembled, small computer system.

For more free information and the address of the OSI Computer Dealer or representative in your area, write to: OSI; Dept. S; Hiram, Ohio 44234 or enclose $1.00 for the full OSI catalog which contains kits from $134 and fully assembled computers from $439.

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As we've frequently noted in *Creative Computing*, a computer without good quality applications software and documentation might just as well be a boat anchor. Fledgling companies in the hobbyist field have sometimes lost sight of this axiom in their rush to get hardware to the market. However, for long term success and even survival, good software and thorough documentation is a must.

One manufacturer, MITS, recognized the need for software early on and established a user library. This, of course, is not the same as manufacturer produced and supported software although it was a step in the right direction. Now, taking another major step, MITS has moved to establish the Altair Software Distribution Company (ASDC). Well, not exactly establish. ASDC is an outgrowth of the Computer Systemscenter, one of the largest of MITS retail dealers (see *Creative Computing*, Vol. 2, No. 6). The Computer Systemscenter was producing software aimed at the small business customer — general ledger, accounts receivable, accounts payable, payroll, inventory management, etc. MITS saw this as valuable for all of its customers and eventually ASDC was set up as a separate company from the Computer Systemscenter although, as in many companies in the industry, several of the key players wear hats in both organizations.

ASCD has two major functions. First, they took over the programs submitted to the Altair User Group as well as the operation of the User Group itself. Prior to being under the wing of ASDC, programs were accepted and distributed "as is." They were not tested or even checked to see if they loaded. Now submittals are thoroughly tested before being duplicated. Also documentation is checked for accuracy and completeness, and rewritten if necessary. This same process is slowly being retrofitted to programs already in the library. It should be noted that documentation is still not going to be your typical 500-page IBM user manual, however it should be sufficient for the average hobbyist.

Part two of this operation is to group a number of programs (5 to 10) together and offer them on cassette tape (Altair format, of course) and on paper tape, possibly even on floppy disc. Target price: $10 for the tape (either PT or cassette) and $10 more for the documentation booklet.

The other main function of ASDC is the production and marketing of commercial software. Currently this consists of the small business accounting packages mentioned earlier along with a word processing/text editing system. These packages are distributed through retail computer stores who license them to the ultimate customer. The license is a 30-year limited use license which essentially prohibits copying, resale, or sublicensing. These software licenses are not inexpensive: the accounting packages complete cost $5000, the inventory management package $2000, and the word processing package $2000. The package includes the programs on floppy disc, complete documentation, and 3 years of maintenance including bug fixes, updates, and modifcations.

The accounting package requires a fairly substantial hardware configuration: Altair 8800B, 48k memory, floppy disc (dual drive preferred) or the new cartridge disc just announced, line printer (Centronics or other RS232 type printer, or the Qume daisy wheel type printer), CRT terminal, and extended disc Basic v.4.0. The hardware cost is about $11,000 which, although expensive by hobbyist standards, is still considerably cheaper than a comparable mini-based small business system.

ASDC has been and is soliciting programs from users. As of March 1977, some 300 serious inquiries had been received. To make sure submittals are serious, a $25 evaluation fee is charged to discourage people from sending in trivial or trashy programs. Programs currently under evaluation cover a wide range of applications: statistical analysis, air conditioning load estimator, hydraulic analysis, medical record keeping, phototypesetting interface (send us one!), and a travel agents package.

Payments to authors are quite flexible at this point as ASDC feels its way along. Payments can be straight royalty, one lump sum, or a combination. Assuming absolutely everything was ready to go as submitted (programs, documentation, etc.) the author could receive as much as 50% on the net price to dealers which, based on other hobbyist components, is likely to be 40 to 50% off retail. Thus on a package that retails for $1000, the author, in the best possible case, could get as much as $250 each. So write up your application and send it in. The per copy royalty is better than book publishing by a long shot, but then how many I-beam load analysis programs can you really expect to sell? ●

For more information, write Altair Software Distribution Company, 3330 Peachtree Road, Suite 343, Atlanta, GA 30326. (404) 231-2308.

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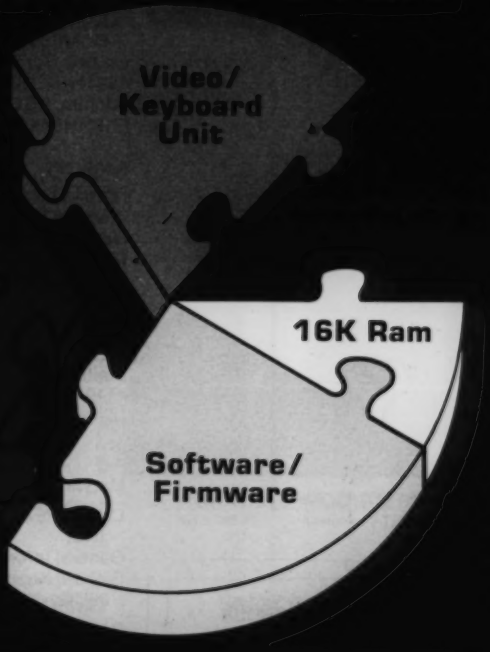

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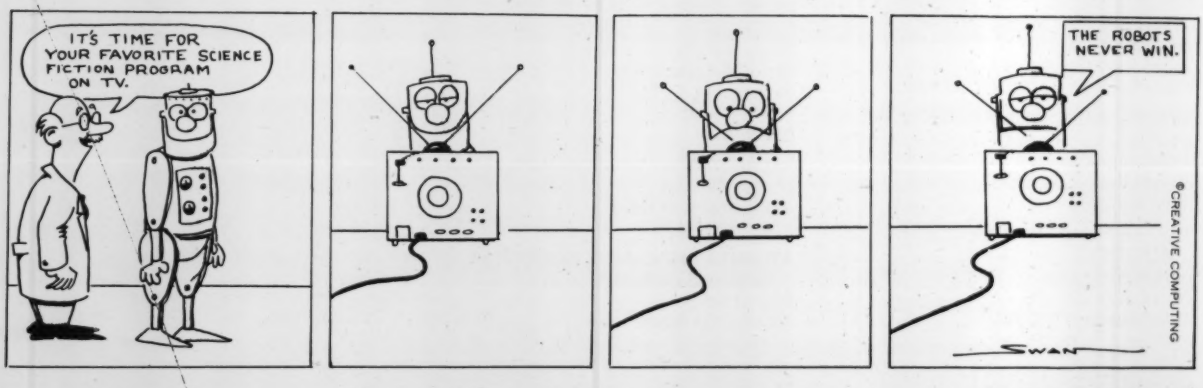

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4018	1.10
4019	.70
4020	.85
4021	1.35
4022	.95
4023	.25
4024	.75
4025	.35
4026	1.95
4027	.50
4028	.95
4030	.35
4033	1.95
4034	2.45
4035	1.25
4040	1.35
4041	.69
4042	.95
4043	1.25
4044	.95
4046	1.50
4049	.80
4050	.60
4066	1.35
4069	.40
4071	.35
4082	.45

— T T L —

7400	.15	7473	.25	74176	1.25	74H72	.55	74S133	.45
7401	.15	7474	.35	74180	.85	74H101	.75	74S140	.75
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7403	.20	7476	.30	74182	.95	74H106	.95	74S153	.35
7404	.15	7480	.55	74190	1.75			74S157	.80
7405	.25	7481	.75	74191	.35			74S158	.35
7406	.35	7483	.95	74192	1.65	74L00	.35	74S194	1.05
7407	.55	7485	.95	74193	.85	74L02	.35	74S257(8123)	.25
7408	.25	7486	.30	74194	1.25	74L03	.30		
7409	.15	7489	1.35	74195	.95	74L04	.35		
7410	.10	7490	.55	74196	1.25	74L10	.35	74LS00	.45
7411	.25	7491	.95	74197	1.25	74L20	.35	74LS01	.45
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7416	.25	7495	.60			74L55	.65	74LS08	.45
7417	.40	7496	.80			74L72	.45	74LS09	.45
7420	.15			75108A	.35	74L73	.40	74LS10	.45
7426	.30			75110	.35	74L74	.45	74LS11	.45
7427	.45	74100	1.85	75491	.50	74L75	.55	74LS20	.40
7430	.15	74107	.35	75492	.50	74L93	.55	74LS21	.25
7432	.30	74121	.35			74L123	.55	74LS22	.25
7437	.35	74122	.55					74LS32	.40
7438	.35	74123	.55	74H00	.25			74LS37	.40
7440	.25	74125	.45	74H01	.25	74S00	.55	74LS40	.55
7441	1.15	74126	.35	74H04	.25	74S02	.55	74LS42	1.75
7442	.55	74132	1.35	74H05	.25	74S03	.40	74LS51	.65
7443	.85	74141	1.00	74H08	.35	74S04	.35	74LS74	.75
7444	.45	74150	1.00	74H10	.35	74S05	.35	74LS86	.75
7445	.80	74151	.75	74H11	.25	74S08	.35	74LS90	1.30
7446	.95	74153	.95	74H15	.30	74S10	.35	74LS93	1.00
7447	.95	74154	.75	74H20	.30	74S11	.35	74LS107	.95
7448	.95	74156	1.15	74H21	.25	74S20	.35	74LS123	1.00
7450	.25	74157	.65	74H22	.40	74S40	.25	74LS151	.75
7451	.25	74161	.85	74H30	.25	74S50	.25	74LS153	1.20
7453	.20	74163	.95	74H40	.25	74S51	.45	74LS157	.85
7454	.25	74164	.60	74H50	.25	74S64	.25	74LS164	1.90
7460	.40	74165	1.50	74H51	.25	74S74	.40	74LS367	.85
7470	.45	74166	1.35	74H52	.15	74S112	.90	74LS368	.70
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THINKING STRATEGIES WITH THE COMPUTER: WORKING BACKWARD

D.T. Piele and L.E. Wood *

"'The so-called 'Treasury of Analysis' is, to put it shortly, a special body of doctrine for the use of those who, after having studied the ordinary Elements, are desirious of acquiring the ability to solve problems."

Pappus, Book VII
Mathematical Collection

Pappus of Alexandria, who lived at the end of the third century A.D., wrote a comprehensive guidebook and commentary on the geometrical works of the great Greek mathematicians Pythagorus, Euclid, Archimedes, and Apollonius—to name a few. His *Mathematical Collection* consists of eight books describing the important developments of the classical Greek geometers and is punctuated with numerous original propositions, improvements, and historical original propositions, improvements, and historical comments of his own. Book VII is historically very important because it collects together the fundamental discoveries of Greek geometers into a "Treasury of Analysis" which, after Euclid's Elements, became essential reading for serious mathematicians of the day. The "Treasury" is also valuable as an early source for heuristic problem-solving strategies. The strategies of *analysis* and *synthesis* are particularly significant because together they constitute the earliest known description of the problem-solving strategy known today as working backward.

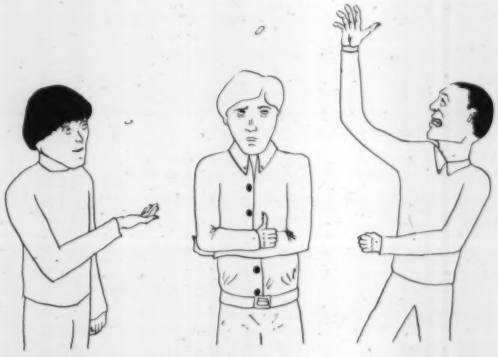
"...for in analysis we assume that which is sought as if it were already done, and we inquire what it is from which this results, and again what is the antecedent cause of the latter, and so on, until, by so retracing out steps, we come upon something already known or belonging to the class of first principles, and such a method we call analysis as being solution backwards.

"But in *synthesis*, reversing the process, we take as already done that which was last arrived at in the analysis and, by arranging in their natural order as consequences what before were antecedents, and successively connecting them one with another, we arrive finally at the construction of that which was sought; and this we call *synthesis*." (7)

*University of Wisconsin-Parkside, Kenosha, Wisconsin 53140

Working Backward

In this second article on problem-solving, we will discuss strategy of *working backward*. Any solution to a problem can be thought of as a path that leads from the given information to the goal. The point Pappus emphasized was that in cases where the goal is known or can be assumed known, it may be easier to start at the goal and work backward to the initial state (analysis). Once this is accomplished, the solution is simply the same series of steps in reverse (synthesis). As an example, consider the following problem.



MATCHING COINS

Three men agree to match coins for money. They each flip a coin and the one who fails to match the other two is the loser. The loser must double the amount of money that each opponent has at that time. After three games, each player has lost once, and has $24. How much did each man begin with?

The end result in this problem is known — all three players end up with $24. The initial state can be found by working backward one game at a time. For example, since each player had $24 after the 3rd game, the two winners of this game (who doubled their money) must have had $12 each at the end of the 2nd game. In order to pay each winner $12 and still end up with $24, the loser of this game must have had $48. Thus the distribution of money among the three players after the 2nd game has been determined. In a similar fashion one can continue working backward to reach the initial state.

If we let P_1, P_2 and P_3 represent the players who lost the first, second, and third games respectively, then Figure 1 shows the distribution of money between the three players at each stage constructed by working backward.

States	Players		
	P_1	P_2	P_3
After 3rd game	$24	$24	$24
After 2nd game	$12	$12	$48
After 1st game	$ 6	$42	$24
Initial State	$39	$21	$12

Figure 1. Solution to Matching Coins

Note that in this problem the path from the goal back to the initial state is uniquely determined; thus at each state in the solution, the previous state is forced upon us by the conditions of the problem. By working backward, we were able to arrive at the solution directly without any detours. This property is illustrated in Figure 2.

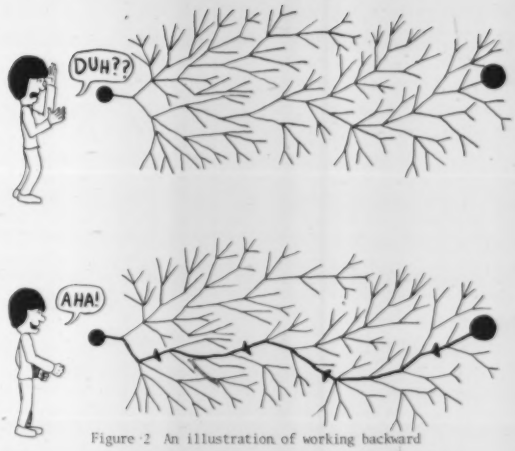


Figure 2 An illustration of working backward

We turn now to a more complex problem where the strategy of working backward is not necessary but where it can be used very effectively in a computer program.

FIVE SAILORS AND A MONKEY

Five sailors and a monkey were on an island. One evening the sailors rounded up all the coconuts they could find and put them in one large pile. Being exhausted from working so hard, they decided to wait and divide them up equally in the morning. During the night, a sailor awoke and separated the nuts into five equal piles, with one left over which he gave to the monkey. He took one pile, hid it, pushed the other four together and went back to his hammock. He was followed in turn by the other four sailors, each of whom did exactly the same thing. Next morning the remaining nuts were divided equally with one remaining nut going to the monkey. What is the least number of coconuts they could have begun with?

Philip W. Brashear (1) derived an elegant algebraic solution to this problem which solves it for any number of sailors. Unfortunately, to conceive such a solution requires a high level of mathematical maturity. But with a computer handy and an understanding of the strategy of working backward, a solution is relatively easy to find.

Consider the general problem where S is the number of sailors on the island and A is the number of coconuts that each sailor received in the final division of the pile. Since one coconut was given to the monkey at every division, the total number of coconuts left in the morning is $S \cdot A + 1$. But this pile came from pushing together $S - 1$ equal piles. Thus, the key condition that must hold is for $(S \cdot A + 1)(S - 1)$ to be an integer K, which represents the number of

coconuts that the last sailor stole from a pile of S•K + 1 coconuts. But this pile is the result of pushing together S - 1 equal piles by the previous theif so again (S•K + 1) (S - 1) is an integer as we move back through all S raids on the pile. This idea is explained further in the flowchart and notes which accompany the SAILOR program.

Conclusion

From textbooks, it is easy to get the impression that there is only one way to solve a problem. The trouble is, our memory soon gets overloaded trying to remember which solution goes with which problem and vice-versa. On top of that, what should you do if classical algebraic or analytical techniques become awkward and difficult to solve? Quit? Never!!! Learn a few simple problem solving skills and start cracking some tough coconuts with the computer. ●

Postscript

The algebraic solution to this problem is given by S(S+1)-(S-1). Thus for S larger than 5, the program given here takes an appreciable amount of time to get an answer. Are there ways to make the program more efficient?

References

1. Brashear, Philip W., "Five Sailors And A Monkey", *The Mathematics Teacher,* October 1967, pp 597-599.

2. Kordemsky, Boris A. *The Moscow Puzzles.* Charles Scribner's Sons. New York 1972.

3. Gardiner, M. *Mathematical Puzzles of Sam Loyd,* Vol. I. Dover Publications, Inc., New York, 1959.

4. Newell, A. and Simon, H.A. *Human Problem Solving.* Prentice-Hall, Inc., Englewood Cliffs, N.J. 1972.

5. Polya, G. *How To Solve It.* Princeton University Press, 1945.

6. Wickelgren, Wayne A. *How To Solve Problems.* W. H. Freeman and Company, San Francisco, 1974.

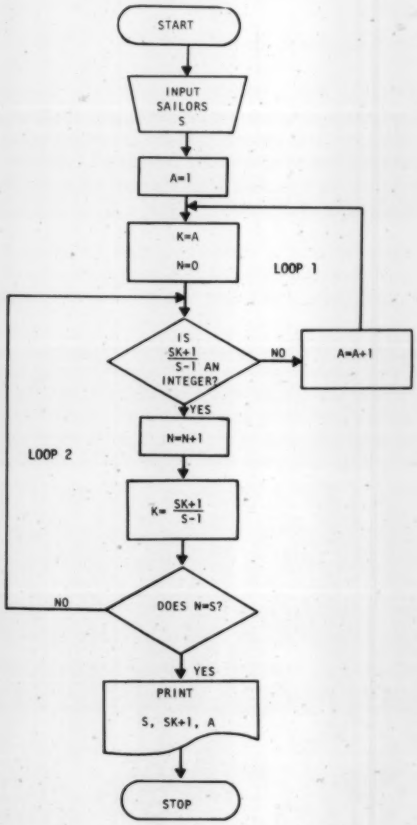
(7) Heath, Sir Thomas L., *The Thirteen Books of Euclid's Elements,* Dover publications, New York, 1956, p. 138.

Illustrations drawn by Robert Schroeter, a student at UW-Parkside.

Flowchart Notes

1. S is the number of sailors on the island.
2. A = 1 is the initial value for the morning share.
3. K is an integer.
4. N is a counter for loop 2.
5. (S•K + 1) (S - 1) is the number of coconuts stolen by sailor number (S - N) the night before.
6. The value of A is increased by 1 in loop 1 until it reaches a number for the final share that could have come from a pile formed by pushing together S-1 equal shares.
7. Loop 2 checks to see when a number is reached for the final share that can survive being pushed back through S consecutive raids and regroupings and still give integers at each stage.
8. The print-out gives the number of sailors, the least number of coconuts they could have begun with, and the share each sailor received in the morning.

FLOWCHART



SAILOR PROGRAM

```
LIST
SAILOR

100  PRINT "THIS PROGRAM SOLVES THE SAILORS AND"
110  PRINT "MONKEY PROBLEM BY WORKING BACKWARDS."
120  PRINT
130  PRINT "HOW MANY SAILORS ARE THERE ON THE ISLAND ";
140  INPUT S
150  PRINT
160  A=1
170  K=A
180  N=0
190  IF (S*K+1)/(S-1)=INT((S*K+1)/(S-1)) THEN 220
200  A=A+1
210  GOTO 170
220  N=N+1
230  K=(S*K+1)/(S-1)
240  IF N=S THEN 260
250  GOTO 190
260  PRINT "THE LEAST NUMBER OF COCONUTS THAT"S
270  PRINT "SAILORS CAN BEGIN WITH IS"S*K+1
280  PRINT
290  PRINT "IN THE MORNING, EACH SAILOR GETS"A
300  END
```

SAMPLE RUN

```
THIS PROGRAM SOLVES THE SAILORS AND
MONKEY PROBLEM BY WORKING BACKWARDS.

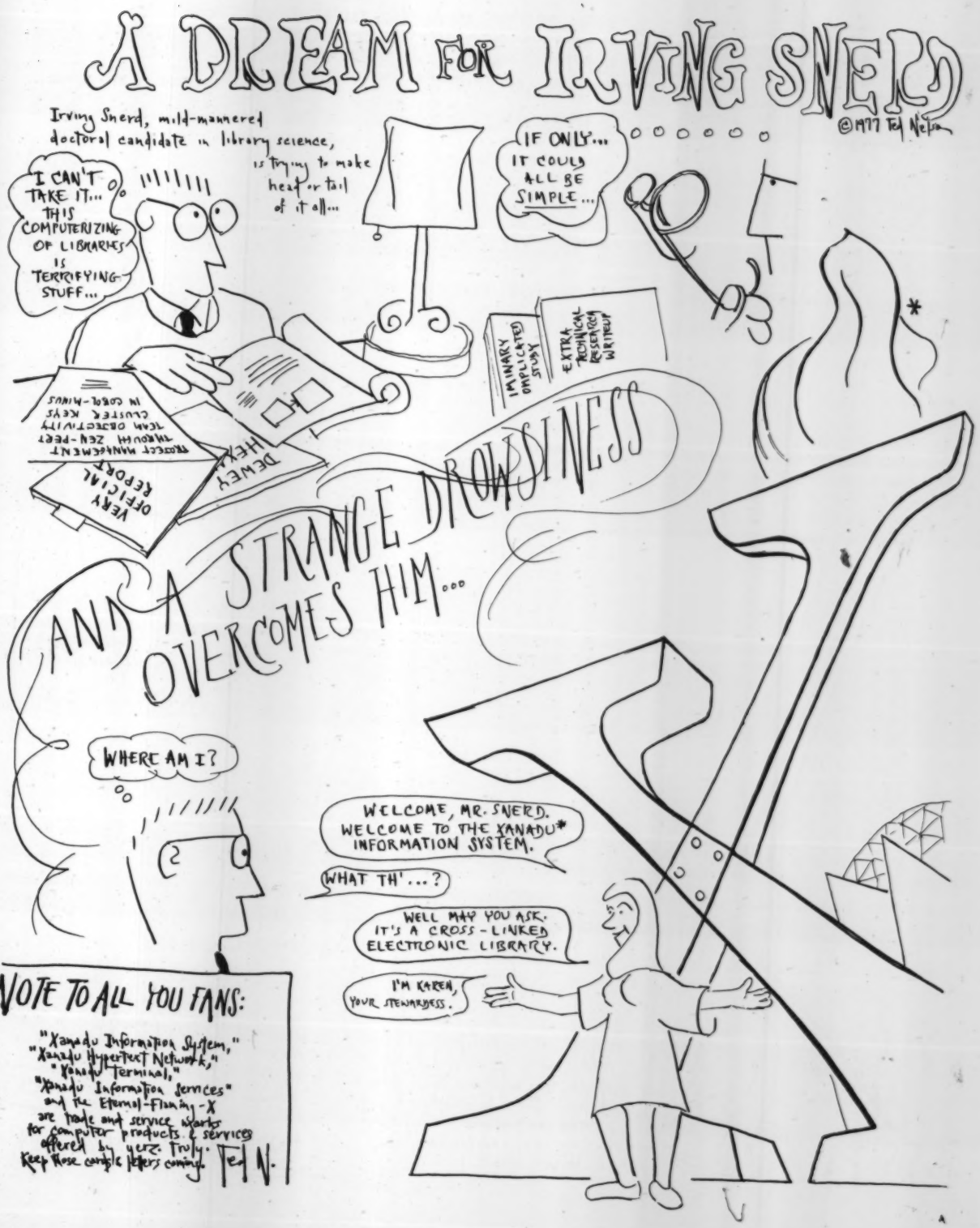
HOW MANY SAILORS ARE THERE ON THE ISLAND ?5

THE LEAST NUMBER OF COCONUTS THAT 5
SAILORS CAN BEGIN WITH IS 15621

IN THE MORNING, EACH SAILOR GETS 1023

DONE
```

A DREAM FOR IRVING SNERD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Irving Snerd, mild-mannered doctoral candidate in library science, is trying to make head or tail of it all...
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VERY OFFICIAL REPORT
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AND A STRANGE DROWSINESS OVERCOMES HIM...
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ALL WRITINGS ARE STORED ELECTRONICALLY NOW. WHATEVER YOU REQUEST AT YOUR SCREEN COMES TO YOU AUTOMATICALLY FROM THE NETWORK.

THERE ARE PEOPLE COME AND WRITE, HOME COMPUTERS.

ALL SORTS OF LOOKUPS ON THE SYSTEM.

TO THIS HYPERTEXT STAND TO READ OR THEY CALL UP THROUGH THEIR

WE'RE DELIBERATELY SETTING IT UP AS A KIND OF CULT — PEOPLE WHO CARE ABOUT THE WRITTEN WORD. THE IMPORTANT THING IS TO MAKE ITS FULL CAPABILITY AVAILABLE TO ALL USERS, NOT PHONILY REDUCED FOR DIFFERENT MODELS OF EQUIPMENT. OUR CLUB OF ALEXANDRIA STUDIES THE IMPORTANT POLICY QUESTIONS...

GRAFFITI CONTEST

I GOT A PORLOCK 7 ** JUST NOW — THIS GUY FOOLED ME INTO HIS DOPEY COLLATERATION OF EDGAR CAYCE WITH THOMAS AQUINAS.

BUT WHY THIS WAY? WHY DIDN'T YOU DO IT THROUGH THE NATIONAL POMPOSITY FOUNDATION? THE INSTITUTE FOR POLYSYLLABIC LEGITIMATION? THE COUNCIL OF SANCTIMONIOUS SOCIETIES ?

The Serendipity Festival was better. Lot of Xanaties.

Are you Mahatma Gandolf ?

I preferred the Interthwingularity Expo. Buncha real Xaniacs.

No, my Xandle's Green Slime.

**KNOW YOUR PORLOCK AND ROSEBUD CODES!
Porlock 1 — a bad Thing. Ick. Porlock 7 — nuisance writings. Porlock 1000 — catastrophe. Rosebud 2 — a pleasant encounter. Rosebud 11 — bon mot, neat screen creation. Rosebud 20 — royalties coming in on your copyrighted creations. (Many codes reserved for future expansion; contributions welcome.)

A jump-link (**) is like a footnote, except when the reader points at the asterisk it can take him anywhere in the entire library.

Collateration (@@) means that corresponding parts of any two things, as somebody has linked them, can be viewed together.

And the quote-window ([[ ]]) means you can instantly see any quotation in its original context.

We call these three linkage modes the "classic set."

They're very simple and very powerful. Someday perhaps we can extend them to graphics and animation. (We can nest and combine them to any depth.)

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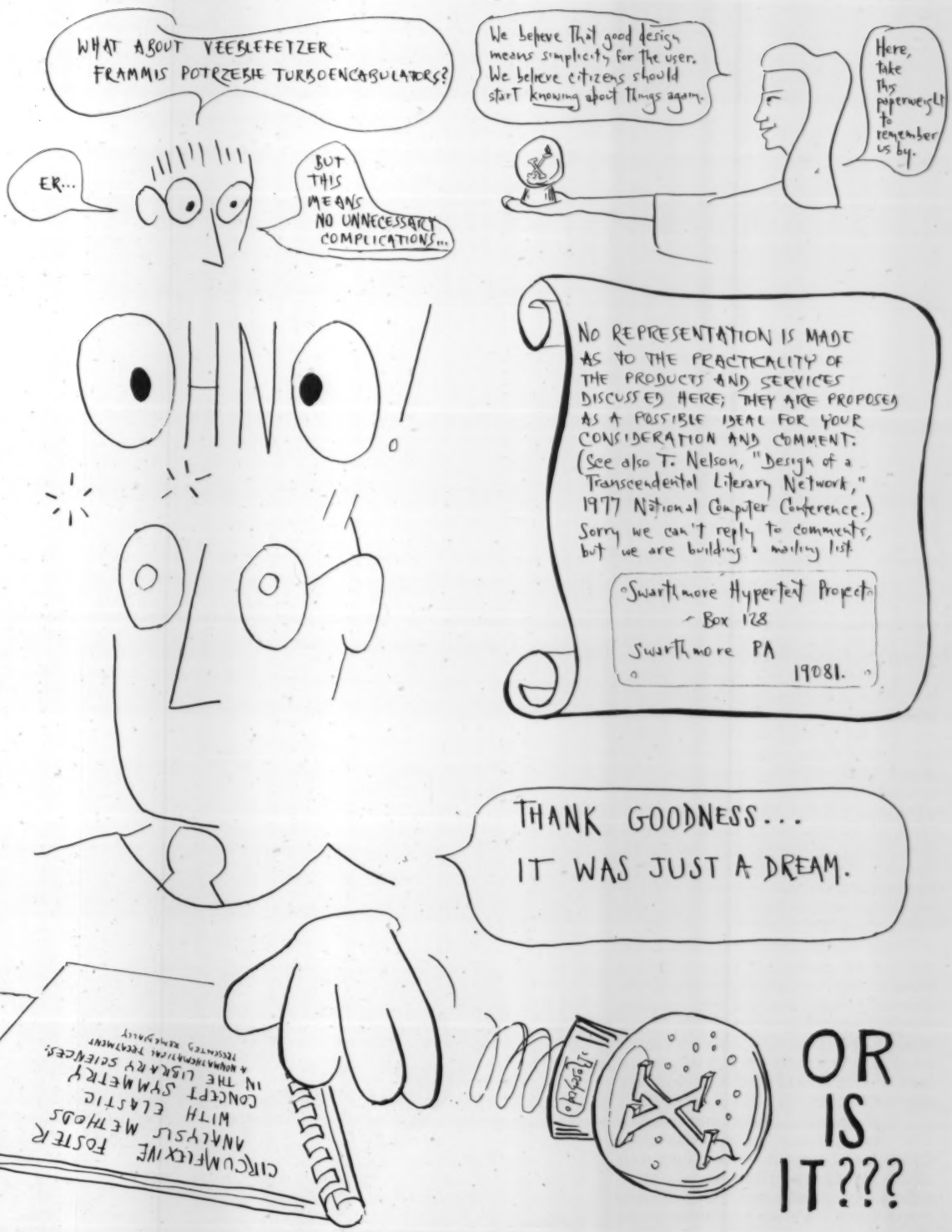
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Computer Assisted Instruction (CAI) was one of the earliest and most successful uses of computers in education. In this series of 5 articles we'll show how you can produce and use CAI software on your home or school computer.

CAI: Mathematics Drill and Practice

David H. Ahl

In its most elemental form, CAI presents drill and practice exercises to a student on a subject that he or she has already learned in class or elsewhere. On larger systems this is refined to the point where the computer keeps track of each student and presents proportionately more material of the type with which the student is having difficulty.

For example, in second grade arithmetic a student may receive drill and practice on horizontal addition, vertical addition, horizontal subtraction, and vertical subtraction in equal doses, i.e., 25% of each type of problem. However, over time the student may miss more of the horizontal type problems, particularly subtraction. In this case after several sessions the ratio of problems might be 30% horizontal addition, 15% vertical addition, 40% horizontal subtraction, and 15% vertical addition.

These problem categories are sometimes known as "strands" and a student may progress along each of the strands independently of other strands and independently of his or her overall grade level. Thus, in an extreme case, a third grader could be at sixth grade level in vertical addition and first grade level in fractions.

This is the type of drill and practice that has proved so successful in Chicago, Compton and numerous other places using large-scale computers or dedicated time-sharing mega-minis. However, there's no reason that we can't produce a similar system for micros and minis, or a non-dedicated time sharing system.

Before we produce a relatively elaborate record-keeping system, it's important to understand some of the basics of writing drill and practice for any computer. For example, consider the following problem:

3 + ___ = 17

Where does the student type the answer? With "normal" high-level languages you can request input to the right of the problem or on the next line (a or b). With cursor addressing you could request input at the more desirable location where it actually belongs (c).

3 + **c** ___ = 17 **a**
b

On a problem like this:

32
- 17
---

do you require the answer as 15 or do you allow the student to work from right to left, first inputting a 5 and then having the cursor back up for the 1?

Initially, we'll assume the only language available is Basic with no extended capabilities and with no cursor addressing. However, the principles of writing CAI are the same no matter what language you're dealing with.

EXAMPLE 1

```
10 RANDØMIZE
20 N=10
30 W=0
40 A=INT(N*RND(0))
50 B=INT(N*RND(0))
100 PRINT
110 PRINT "  ";A
130 PRINT "+ ";B
140 R=A+B
200 PRINT "------"
210 INPUT G
220 IF G=R THEN 300
230 W=W+1
240 IF W>1 THEN 270
250 PRINT "WRØNG, TRY AGAIN."
260 GØTØ 100
270 PRINT "YØU MISSED THAT ØNE TWICE."
280 PRINT "THE CØRRECT ANSWER IS ";R
290 GØTØ 310
300 PRINT "CØRRECT !!"
310 PRINT "HERE'S ANØTHER..."
320 GØTØ 30
999 END
```

Numbers in problems will be between 0 and 9.

R = Right answer
G = "Guess" or student input

```
   2
 + 0
------
? 2
CØRRECT !!
HERE'S ANØTHER...

   1
 + 7
------
? 8
CØRRECT !!
HERE'S ANØTHER...

   1
 + 7
------
? 8
CØRRECT !!
HERE'S ANØTHER...

   6
 + 2
------
? 9
WRØNG, TRY AGAIN.

   6
 + 2
------
? 10
YØU MISSED THAT ØNE TWICE.
THE CØRRECT ANSWER IS  8
HERE'S ANØTHER...

   9
 + 1
------
? 10
CØRRECT !!
HERE'S ANØTHER...

   7
 + 8
------
? STØP
PRØGRAM HALTED
```

Two chances to get the correct answer seems about right with young children.

EXAMPLE 2

```
25 P=0
60 P=P+1
70 IF B<=A THEN 100
80 C=A
85 A=B
90 B=C
120 IF P/2=INT(P/2) THEN 160
150 GØTØ 200
160 PRINT "  - ";B
170 R=A-B
```

Make sure that a smaller number (B) is subtracted from the larger (A).

Alternate between addition and subtraction problems.

```
   6
 + 2
------
? 8
CØRRECT !!
HERE'S ANØTHER...

   8
 - 2
------
? 6
CØRRECT !!
HERE'S ANØTHER...

   7
 + 2
------
? 10
WRØNG, TRY AGAIN.

   7
 + 2
------
? 9
CØRRECT !!
HERE'S ANØTHER...

   9
 - 3
------
? 6
CØRRECT !!
HERE'S ANØTHER...

   7
 + 5
------
? 12
CØRRECT !!
HERE'S ANØTHER...

   7
 - 4
------
? 3
CØRRECT !!
```

Example 1 generates and presents vertical addition problems. It doesn't keep score, it doesn't use cursor addressing, it doesn't have timing, it doesn't even keep columns of numbers lined up, but it's a starting point. And, incidentally *it is useful.* Children are incredibly adaptable and it's frequently easier to get a child to accept a less-than-beautiful format on the computer than to go through the programming gyrations to get everything "just right." The *really important* reasons that CAI is so successful is that it is personal, it is self-paced, it is not critical (in an ego deflating or destructive way), and it is infinitely patient. All these factors are present in Example 1 even though it lacks the niceties of more sophisticated programs.

Notice the following features:

- *Problem difficulty.* This is set in Statement 20. Currently the number range is between 0 and 9. N determines the upper range of numbers used in problems.
- *Number of trials allowed.* Statement 230 counts the number of times a problem is gotten wrong. Statement 240 allows two trials; if you wish to allow 3 trials before giving the correct answer, then Statement 240 should be IF W 2 THEN 270.

By adding 10 statements to Example 1 (see Example 2) we can present addition and subtraction problems alternately. Statement 60 is a problem counter; Statement 120 branches to subtraction problems on even numbers. Statements 70 through 90 simply make sure that a smaller number is being subtracted from a larger one (not necessary, of course, if the student understands the concept of negative numbers).

Example 3, for multiplication problems adds two additional features not in Examples 1 or 2:

- *Personal feedback.* The child's name, input in Statement 10, is used liberally in comments throughout the exercise (Statements 114,145,220).
- *Scoring.* Variable R counts the number of problems right on the first or second trial and Statements 210-220 compute the total score.

EXAMPLE 3

```
2 RANDØMIZE
5 PRINT "MULTIPLICATIØN PRACTICE."
10 PRINT "YØUR NAME";
12 INPUT A$
14 PRINT\PRINT "HI ";A$;".  TØ STØP, TYPE 999 FØR YØUR ANSWER."
15 R=0\P=-1
20 P=P+1
25 Q=0
30 A=INT(12*RND(0)+1)
40 B=INT(10*RND(0)+1)
50 PRINT
60 PRINT "    ";A
70 PRINT "  X ";B
80 PRINT "  ------"
90 PRINT "  ";
100 INPUT G
110 IF G=A*B THEN 140
111 IF G=999 THEN 200
112 IF Q<1 THEN 122
114 PRINT "YØU MISSED THAT ØNE TWICE,";A$
115 PRINT "THE CØRRECT ANSWER IS ";A*B
117 PRINT
120 GØTØ 20
122 Q=Q+1
125 PRINT "NØ.  TRY AGAIN."
130 GØTØ 50
140 R=R+1
145 PRINT "RIGHT, ";A$
150 GØTØ 20
200 PRINT
210 PRINT "YØU GØT";R;"RIGHT ØUT ØF";P;"PRØBLEMS."
215 S=INT(100*R/P)
220 PRINT "SCØRE IS";S;"PERCENT, ";A$
230 END
```

Personalization is nice if your Basic has string variables.

The first number will vary between 1 and 12; the second between 1 and 10.

Count correct answers

Present score.

```
MULTIPLICATIØN PRACTICE.
YØUR NAME? DEREK

HI DEREK.  TØ STØP, TYPE 999 FØR YØUR ANSWER.

    9
  X 7
  ------
  ? 54
NØ.  TRY AGAIN.
    9
  X 7
  ------
  ? 64
YØU MISSED THAT ØNE TWICE,DEREK
THE CØRRECT ANSWER IS  63

    2
  X 3
  ------
  ? 6
RIGHT, DEREK

    11
  X 7
  ------
  ? 77
RIGHT, DEREK

    5
  X 4
  ------
  ? 20
RIGHT, DEREK

    10
  X 8
  ------
  ? 80
RIGHT, DEREK

    4
  X 6
  ------
  ? 24
RIGHT, DEREK

    2
  X 3
  ------
  ? 6
RIGHT, DEREK

    1
  X 1
  ------
  ? 999

YØU GØT 6 RIGHT ØUT ØF 7 PRØBLEMS.
SCØRE IS 85 PERCENT, DEREK
```

This program does not right justify digits, however, most children seem to be able to adjust to this format.

Scoring, like grades may not be desirable. It all depends upon your point of view.

Let's now take a bigger jump to Example 4 which presents 9 different types of horizontal and vertical addition and subtraction problems Starting with the same basics, we've added some additional features:

- *Digit alignment* in vertical problems. Statements 114, 115, and 401 determine how many spaces to tab over (Statements 210, 220, etc.) so that the digits are right justified.
- *Different reinforcement messages.* Problem counter Y coupled with Statements 750-795 alternates between 4 reinforcement messages. More could be used, of course.

Notice that scoring is not in this program. Scoring is most valuable when it is an internal variable used to alter the ratio of different types of problems in response to what the child is getting right or wrong. However many children feel threatened by scores (like grades) so it may not be desirable to print it out.

Next issue we'll look at how the scores on different types of problems can be used to vary the ratio of problem types presented and we'll also look at keeping records from one session to the next. ●

EXAMPLE 4

```
10 RANDØMIZE
20 N=15
30 PRINT "HI.  WHAT'S YØUR NAME";
40 INPUT A$
50 PRINT
60 PRINT "ØK, "A$", WE'RE GØING TØ DØ SØME ARITHMETIC PRØBLEMS."
80 E=0
85 Y=0
90 FØR P=1 TØ 18
100 A=INT(N*RND(0)+1)
105 B=INT(N*RND(0)+1)
110 IF A>B THEN 114
111 D=B
112 B=A
113 A=D
114 S=3-INT(LØG(A)/2.302585+1)
115 T=2-INT(LØG(B)/2.302585+1)
120 Q=P
130 IF P<10 THEN 150
140 Q=P-9
150 ØN Q GØTØ 200,250,300,350,400,450,500,550,600
200 R=A+B
210 PRINT TAB(S);A
220 PRINT TAB(T);"+";B
225 PRINT "------"
230 INPUT G
235 GØSUB 700
240 IF E>0 THEN 210
245 GØTØ 680
250 R=A-B
260 PRINT A" - "B" = ";
270 INPUT G
280 GØSUB 700
290 IF E>0 THEN 260
295 GØTØ 680
```

Numbers in problems vary between 1 and N.

Determines the width of a number.

Vertical addition 11 + 2

Alternates between the 9 problem types.

Horizontal subtraction 12 - 4 = ___

```
300 R=A-B
310 PRINT TAB(T)" "B
320 PRINT "+"
 325 PRINT "------"
330 PRINT TAB(S);A,,
332 INPUT G
335 GØSUB 700
 340 IF E>0 THEN 310
345 GØTØ 680
350 R=A-B
360 PRINT A" -         = ";B,,
370 INPUT G
380 GØSUB 700
 390 IF E>0 THEN 360
395 GØTØ 680
400 C=INT(N*RND(0)+1)
401 U=3-INT(LØG(C)/2.302585+1)
402 R=A+B+C
410 PRINT TAB(S);A
415 PRINT TAB(U);C
420 PRINT TAB(T);"+";B
425 PRINT "------"
430 INPUT G
435 GØSUB 700
440 IF E>0 THEN 410
445 GØTØ 680
450 R=A+B
460 PRINT A" + "B" = ";
470 INPUT G
480 GØSUB 700
490 IF E>0 THEN 460
495 GØTØ 680
500 R=A-B
510 PRINT TAB(S);A
520 PRINT TAB(T)"-"B
525 PRINT "------"
530 INPUT G
535 GØSUB 700
540 IF E>0 THEN 510
545 GØTØ 680
550 R=A-B
560 PRINT B" +         = "A,,
570 INPUT G
580 GØSUB 700
590 IF E>0 THEN 560
595 GØTØ 680
600 R=A-B
610 PRINT TAB(S);A
615 PRINT "-"
 620 PRINT "------"
625 PRINT TAB(T)" "B,,
630 INPUT G
635 GØSUB 700
640 IF E>0 THEN 610
645 GØTØ 680
680 NEXT P
690 GØTØ 900
700 IF G=R THEN 750
705 E=E+1
710 IF E>2 THEN 800
720 PRINT "WRØNG.  TRY AGAIN."
725 PRINT
730 RETURN
750 Y=Y+1
752 E=0
755 ØN Y GØTØ 760,770,780,790
760 PRINT "VERY GØØD "A$
765 GØTØ 725
770 PRINT "SUPER !"
775 GØTØ 725
780 PRINT "THAT'S RIGHT "A$
785 GØTØ 725
790 PRINT "CØRRECT !"
792 Y=0
795 GØTØ 725
800 PRINT "YØU MISSED THAT ØNE 3 TIMES "A$"."
805 PRINT "THE CØRRECT ANSWER IS "R"."
810 PRINT "HERE'S ANØTHER PRØBLEM."
815 E=0
820 GØTØ 725
900 PRINT
910 PRINT "THAT WAS LØTS ØF FUN "A$"."
920 PRINT "DØ YØU WANT ANY MØRE PRØBLEMS TØDAY (YES ØR NØ)";
930 INPUT B$
940 IF B$="YES" THEN 85
950 IF B$="NØ" THEN 960
953 PRINT "PLEASE ANSWER 'YES' ØR 'NØ'."
955 GØTØ 920
960 PRINT
970 PRINT "ØK.  GØØDBYE FØR NØW "A$".  PLEASE TYPE 'BYE' AND"
980 PRINT "HANG UP THE PHØNE.  THANKS."
999 END
```

Vertical addition (type 2)

```
  2
+ _
---
  7
```

Horizontal subtraction (type 2)

8 - __ = 5

Vertical addition

```
 10
  3
 10
```

Horizontal addition

15 + 1 = __

Vertical subtraction

```
 15
-15
```

Horizontal addition (type 2)

2 + __ = 11

Vertical subtraction (type 2)

```
 10
 -
---
 10
```

Subroutine to check answer (G) against correct one (R). E counts the number of incorrect trials.

Alternates between 4 reinforcement messages.

```
HI.  WHAT'S YØUR NAME? DETTA

ØK, DETTA, WE'RE GØING TØ DØ SØME ARITHMETIC
  11                                PRØBLEMS.
 + 2
------
? 13
VERY GØØD DETTA

 12  -  4  = ? 8
SUPER !

   2
+
------
   7                                ? 5
THAT'S RIGHT DETTA

 8  -         = 5                   ? 3
CØRRECT !

  10
   3
+ 10
------
? 23
VERY GØØD DETTA

 15  +  1  = ? 16
SUPER !

  15
- 15
------
? 1
WRØNG.  TRY AGAIN.

  15
- 15
------
? 10
WRØNG.  TRY AGAIN.

  15
- 15
------
? 20
YØU MISSED THAT ØNE 3 TIMES DETTA.
THE CØRRECT ANSWER IS  0 .
HERE'S ANØTHER PRØBLEM.

 2  +       = 11                    ? 9
THAT'S RIGHT DETTA

  10
  -
------
  10                                ? 1
WRØNG.  TRY AGAIN.

  10
  -
------
  10                                ? 0
CØRRECT !

  13
 + 6
------
? 19
VERY GØØD DETTA

 5  -  1  = ? 4
SUPER !

  10
+
------
  13                                ? 3
THAT'S RIGHT DETTA

 13  -         =  8                 ? 5
CØRRECT !

  12
   5
 + 2
------
? 19
VERY GØØD DETTA
```

Without cursor addressing, the answer required here must be input here.

Answers to problems like this must be input as 23, not 3 then 2 which may be what the student is used to.

Eeny, Meeny, Micro And More

Alan B. Salisbury

Until the relatively recent arrival of the microprocessor and microcomputer on the scene, "personal computing" has been largely limited to the privileged few with access (authorized or "bootleg") to the computer facilities of their employers or the computers in their schools, colleges and universities. A mere handful could be found who could either afford to buy their own minicomputer or were resourceful enough to construct their own equipment.

This picture is rapidly changing. As the readers of *Creative Computing* are well aware, the age of the affordable computer has already arrived for many and will soon be here for the rest—all thanks to the microprocessor. For the computer hobbyist considering buying or building a personal computer, there are many factors which should be taken into consideration.

Some Definitions

First, the distinction between a micro*processor* and a micro*computer* should be clearly understood. A microprocessor can be simply defined as a central processing unit (CPU) on a single LSI chip (or, in some cases, set of chips). As illustrated in figure 1, the CPU consists of the arithmetic and logic unit (ALU) with its working registers, and the control unit of a computer. It therefore does *not* include the main memory or the input/output driving circuitry and interfaces. Earlier microprocessors even excluded the clocking circuitry from the basic CPU chip.

To qualify as a micro*computer,* the total hardware, a micro*processor* may be available as a single LSI chip, while a micro*computer* may be available on a single card. We can carry this one step further and define a microcomputer *system* as a microcomputer plus the required supply, control panel (this may be as little as an on/off switch), chassis or cabinet, and some (at least minimal) input/output devices.

Microprocessors

With this perspective, one can now appreciate that a $19.95 microprocessor is a long way from being a working computer (typically, at least several hundred dollars away). Still, within every microcomputer there beats a microprocessor heart that gives it its "personality." The implications of this are many and some of these will be discussed later in this article. For now, let's take a closer look at the types of microprocessors commonly found.

It was mentioned earlier that the CPU may be on a single chip or made up of a set of chips. Single-chip CPU's are most common today. They accommodate a fixed word size of 4, 8, 12, or (recently) 16 bits, and have a fixed (predefined by the manufacturer) instruction set.[1] Both binary and binary-coded-decimal modes can be found, and the total number of different machine language instructions available is on the order of 100. Typical instructions execute in several microseconds.

A good example of this type of microprocessor is the popular Intel 8080 (see Figure 2). The 8080 is an 8-bit microprocessor with 78 different instructions, packaged in a single 40-pin dual in-line package (DIP). Pin-compatible 8080's are also available from other sources in addition to Intel. Newer versions of the 8080 operate faster, require less external support, and some have expanded instruction capabilities.

For comparison, Table 1 illustrates characteristics of several of today's more popular microprocessors. These are the ones

1. Suggested background reading for those not familiar with these terms is "Beyond Basic" in the Nov-Dec 1976 issue.

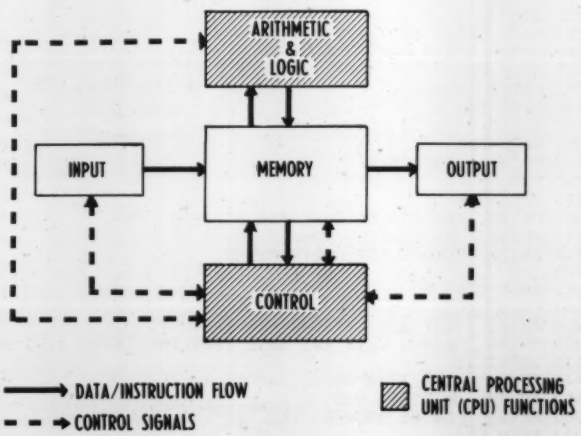


FIGURE 1: FUNCTIONAL BLOCK DIAGRAM OF A TYPICAL COMPUTER

found in many of the microcomputer systems and kits currently on the market. The Z-80, in particular, is interesting because of its relationship to the 8080. While it is not pin-compatible with the 8080 (that is, you can't unplug one and replace it with the other), all 8080 instructions are also present in the Z-80, and therefore an 8080 program will run on the Z-80. The Z-80 can be viewed as a "super" 8080 with a lot of expanded capabilities. (Note, however, that a Z-80 program will *not* necessarily run on an 8080!)

In addition to the basic CPU chip, each micro is complemented by a set of available memory and I/O interface chips. Caution must be taken in selecting add-on memories and such to insure that chips are compatible with one another (that is, common logic voltage levels and the like), or, in the case of complete cards, that they will properly interface with one another. True industry-wide standards do *not* yet exist in this area.

"Bit-Slice" Micros

A separate class of microprocessor chips is referred to as "bit-slice." Each bit-slice chip contains an elemental portion (for example, 2 bits) of an arithmetic and logic unit plus a similar of the working registers. An 18-bit CPU (Figure 3) could be assembled in this case by interconnecting 9 register/ALU chips and adding a separate chip for the control unit. Machines of arbitrary size can be built in this manner.

The control units for bit-slice micros usually do not have predefined fixed instruction sets. The detailed step-by-step execution of an instruction is governed by the information contained in a separate control memory. In effect, this kind of control unit is a "computer within a computer" and the control memory contents are referred to collectively as a "microprogram."[2] It is therefore possible for the user to define his own instruction set, or to "emulate" (that is, copy) the instruction set of another computer in order to use the same software.

Examples of bit-slice chip sets are the Intel 3000 and AM 2900 series devices. Each series includes many devices to provide the capability of building very sophisticated computers, probably more "mini" than "micro" in performance and complexity. Bit-slice micros are best left to the engineer or the hardware oriented hobbyist.

Technology

Most of today's commercially available microprocessors utilize n-channel metal-oxide-semiconductor (NMOS) technology. MOS technology is the technology associated with the "field effect" transistor. NMOS, although slightly more complex than PMOS, offers a decided speed advantage over the latter.

The fastest microprocessors available are generally of the "bi-polar" transistor-transistor logic (TTL) type. Bi-polar technology is that used in the common PNP or NPN transistors. The density of these devices (that is, the number of equivalent transistors that can be placed on a single chip) is considerably less than MOS and the power required is higher. On the other hand, they operate at much faster speeds. For these reasons, bipolar technology is often used in the bit-slice class of micros.

A relative newcomer in the field is "integrated injection logic" or I2L, a relative of bi-polar technology. I2L promises densities and power requirements comparable to MOS, with speed even better than MOS.

Memories

Two types of memories may be used within microcomputers: "read/write" and "read-only." Read only memories (ROMs), as their name implies, may be read but not written (altered) under program control. ROMs are most often employed in microcomputer systems that are dedicated to a single application such as a process controller. The program in this

2. Note that "microprogramming" is *NOT* simply the same as programming a microprocessor! Generally, a *microprogram defines* the instruction set, *while the machine language program uses* those instructions.

MICRO PROCESSOR: / FEATURE:	Word Length	Technology	Number of Instructions	Instruction Execution Time (microseconds)	Registers	COMMENTS/NOTES
FAIRCHILD F-8	8-bit	NMOS	74	2	Accumulator **(Note 1)** 64 Gen Purpose	1. Indirect addressing used to reach all but 12 Gen purp registers.
INTEL 8080	8-bit	NMOS	78	2	Accumulator 6 Gen Purpose Stack Pointer	8085 integrates support chips with CPU, is faster. PL/M language
INTERSIL 6100	12-bit	CMOS	60+	5	Accumulator MQ	Emulates PDP-8 instruction set!
MOTOROLA 6800	8-bit	NMOS	72	2	2 Accumulators Index Stack Pointer	Instruction set is similar to PDP-11. MPL language
TEXAS INST 9900	16-bit	NMOS	69	2.7	(Note 2)	2. Uses memory-to-memory instructions, without CPU working registers.
ZILOG Z-80	8-bit	NMOS	158	1.6	2 banks	Super 8080, software compatible (upward 8080 to Z-80) but not pin compatible. PL/Z language.

TABLE 1. A Comparison of Several Popular Microprocessors

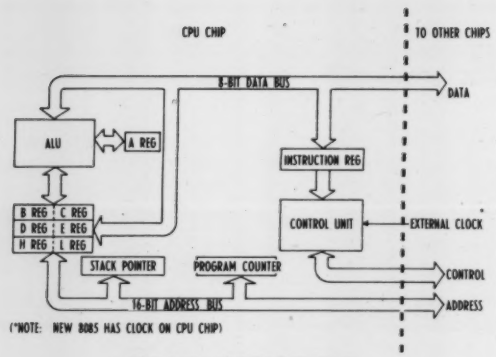


FIGURE 2- INTEL 8080 CENTRAL PROCESSING UNIT

type of application normally remains constant. A small amount of separate read/write memory is often included for data which may be variable. Another use of ROMs is for the control memory of a microprogrammed computer as described earlier. In this case they are often referred to as "firmware." Finally, key systems programs (monitors, interpreters, etc.) are sometimes provided by microcomputer manufacturers in ROM form to eliminate the necessity of having to read them into memory.

General-purpose microcomputers of interest to the computer hobbyist require read/write memories for both programs and data. Read/write memory chips are usually called RAM (in contrast to ROM), for "random access memory."

RAM's may either be "static" or "dynamic." Dynamic RAM's have the disadvantage of requiring a periodic "refresh" or they will lose their information, and this requires extra circuitry. "Volatile" memories of this type lose their contents when power is cut off, just as most pocket calculators do. Unless the system has fairly high-speed input devices for loading memory, or keep-alive batteries, volatile memories leave a lot to be desired.

A key factor concerning memories is capacity. Usually memory is available in increments of 1K (K = 1000) words. From the hardware standpoint a system should be able to accommodate additional plug-in boards to expand memory (that is, physical space in the cabinet, plus power), and the boards must electrically interface with the CPU. The more popular micros have already seen independent companies providing "plug-compatible" memories for their products. From the software standpoint, a micro may be limited in the amount of memory which its instruction set can address, but that limt is generally considerably higher than most hobbyists will require.

Connections between IC chips (CPU, memory, input/output interfaces, etc.) normally utilize "buses." A bus is simply a parallel set of lines grouped together as a set. More than one device can be connected to a bus at the same time with addresses or "select" lines used to cause the desired one to respond while others ignore a signal. Separate buses may be used for addresses, data, or control functions. In the case of memories, a CPU could, for instance, place a memory address on an address bus, a "read" command on a control bus, and receive the contents of the desired memory location on a data bus.

Input/Output and Peripherals

One of the biggest problems faced by the computer hobbyist is finding suitable input/output devices at a reasonable price. Those who have spent much time on commercial minis or larger computers find the performance of the affordable range of input/output devices somewhat disappointing.

Two general types of I/O interface are provided with most microcomputers. Serial interfaces (one bit at a time, sequentially) are probably the most practical since they can be used with more common input/output devices available for the hobbyist. Parallel interfaces (multiple bits simultaneously, usually 8 to form a complete character) are more powerful but require greater equipment sophistication.

The most economical input device available is a simple alphanumeric keyboard. These are widely used and most microcomputers have suitable interfaces either as a standard feature or as an option. A keyboard is ideal for interactive work such as working with short programs in BASIC. They can be quite frustrating, however, when used for loading long programs since they are limited in speed to the user's typing speed. On the other hand, a full alphanumeric keyboard is far better than a limited numeric or hexadecimal (0 thru 9 plus A thru F keys) keyboard or set of sense switches; these devices require entry of data either in binary form or 4 binary bits at a time encoded into hexadecimal.

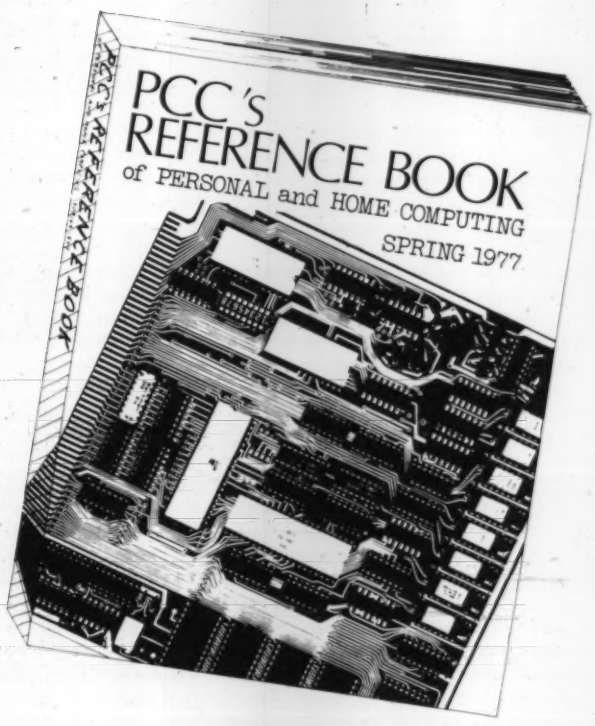
On the output side, video terminals are both effective and practical. Their practicality stems from the fact that it is possible to use a normal home TV set for this purpose without any modifications. Typically 1024 characters can be displayed on the screen at any time. Again, this is a very effective output medium for interactive use. The disadvantage here lies not in speed, but in permanence, since no "hard copy" is available. As with keyboards, interfaces for video output are generally available as options for microcomputers, and in some cases are standard.

Medium and high-speed input/output devices and "hard-copy" terminals are still prohibitively expensive for most hobbyists. Surplus teletypewriters (with or without paper-tape readers and punches) are one of the better buys, but even so they probably cost two to three times the price of the basic microcomputer. Also, except for the mechanically minded, they can present troublesome maintenance problems.

Cassettes

Cassette tape recorder/players perhaps provide the light-on-the-horizon of the input/output and peripheral dilemma for the hobbyist. While special digital cassette tape drives have been developed for the computer industry, normal audio-cassette recorders are proving to be very satisfactory for personal computing. Even the less expensive devices with reasonable quality audio tape work well. There are a number of techniques for handling digital data on audio tapes and, to date,

"Computer, computer on my wall... who's the fairest of them all?



FINALLY! A Reference Book for Home Computer Users

Ever try to find the addresses of some manufacturers of, say, tape cassette or floppy disc interfaces for micros? Frustrating, isn't it? We know, because we've been frustrated by it too, so we decided to do something about it. People's Computer Company is publishing a valuable reference directory that will go a long way towards ending that frustration.

Here's just some of the information you'll find in *PCC's Reference Book of Personal and Home Computing – Spring, 1977.*

- ☆ Hundreds of companies and stores selling hardware, software, peripherals and offering all sorts of services are listed with their brand names and addresses.
- ☆ Nuts-and-bolts and survey articles on software, hardware, kits, applications, and the future, just to name a few, for the experienced and the not-so-experienced user of microcomputers.
- ☆ An index of the articles from the major hobbyist magazines plus information on magazines in the field.
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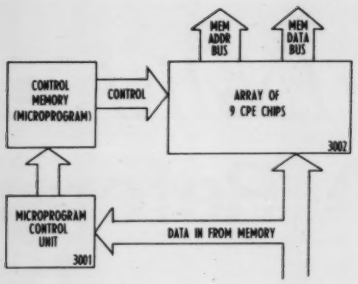

FIGURE 3b: INTEL 3000 SERIES CONFIGURED AS 18-BIT CPU

there are no real standards. Nevertheless, a few suitable techniques have been published and are finding wide acceptance for hobbyist use.

The utility of cassettes lies in their ability to provide a high-speed (compared to keyboard) input medium and permanent storage for retaining long programs after they have been developed. Standards further permit the exchange of programs in machine-readable form between those using the same standard.

Support Systems

Several types of support systems are marketed to support development of microprocessors for industrial and commercial applications. These are aimed primarily at the developer of systems in which the program will be implemented in ROM for a fixed application. The idea is to permit use of read/write memory during development so that the expense and inflexibility of ROM's can be delayed until all the bugs are out of the program.

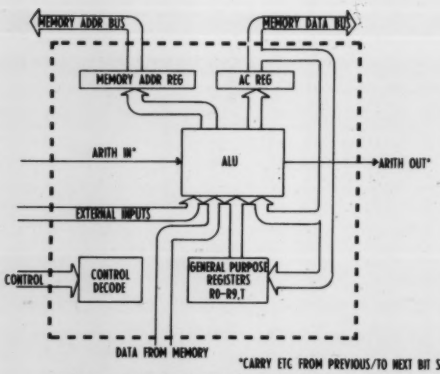

FIGURE 3a: INTEL 3002 CENTRAL PROCESSING ELEMENT (2-BIT SLICE)

Emulators (sometimes called in-circuit emulators) are essentially complete microprocessor or microcomputer systems with RAM instead of ROM. When a microcomputer with ROM is to be embedded in a larger system, an emulator can be inserted in its place with its program in RAM to permit checkout of the overall system.

Another way to test programs is by using a simulator. A simulator is usually a program that runs on a larger computer (often a time-sharing system) that simulates detailed execution of a microprocessor program. It accepts microprocessor machine-language or assembly-language programs as input and produces the same output which the actual microprocessor would, sometimes with diagnostic information included to help find program bugs.

Software

Probably the single most important factor that should be considered in selecting a microcomputer for personal use is software. With very few exceptions, software written for one microprocessor type will not operate correctly on a different type. For example, an Intel 8080 program will not run on a Motorola 6800. Therefore, careful thought should be given to the microprocessor which will be the CPU of your microcomputer. Its instruction set and registers make up its unique "personality" alluded to earlier.

Staying with almost any of the mainstream microprocessors will ensure availability of a fairly wide range of software, some from the manufacturer of the chip itself, some from the microcomputer manufacturer, and some from other users and independent developers. There *are* differences in what's available, however, and it would be well to consider these according to individual needs and desires.

Systems software availability will to a large extent determine the limitations of a microcomputer system. The various kinds of systems software were fully described in the Nov-Dec 76 issue of *Creative Computing,* and most of the program types described in that article are applicable to microcomputers.

Many versions of BASIC have been developed specifically for microcomputers, and they have varied capabilities according to the amount of memory available in a system. Minimal memory sizes of 1-2K words are required for almost any systems software, with 4K really providing a baseline capability. Once again, readers are cautioned to beware of incompatibilities between BASICs, even though on the surface they may appear to be the same. BASIC for micros is usually of the interpreted variety rather than compiled.

Compilers and assemblers with much sophistication are generally "cross" compilers and "cross" assemblers; that is, they compile or assemble machine-language programs for a particular microprocessor, but they themselves run on a larger computer, perhaps accessible through a time sharing system.

"The housewives are no longer complaining about dishpan hands. Now they've got push-button fingers."

Few true compilers for microcomputers are around today. The predominant language used for those that are available is PL/M, a derivative of PL/1 pioneered by Intel. A similar (not identical) derivative also beginning to appear is MPL from Motorola.

Operating systems for low-end personal microcomputers are rather primitive unless considerable memory is available. Monitor facilities which aid in checking out programs are frequently found, often implemented in ROM.

Summary

Moving from a terminal on to your own truly personal computer can open up a whole new world of fun—and challenge—FOR THE COMPUTER HOBBYIST. Whether you decide to build your own or buy an off-the-shelf microcomputer, you should plan ahead, well beyond the system you initially obtain. As your capabilities and desires expand, so must your hardware and software. A carefully chosen system will be able to evolve along with your needs.

The "big picture" in the microprocessor/microcomputer arena is continuously changing. Many 16-bit microprocessors are either in production or already announced. Some are even micro**computers** on a single chip, including one with the full NOVA instruction set! Another consideration is that TV games are rapidly approaching the classification of personal computing, as the newest programmable systems from Fairchild and RCA have demonstrated. For some, this may be the best way to get into personal computing.

Certainly it can be anticipated that new IC developments will soon be showing up in the assembled microcomputer and microcomputer kit marketplace. Waiting for this to happen may ensure you never get your own computer though, because in this field there will always be something significantly better "just around the corner." ●

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Historians say Babbage's analytical engine couldn't be built in his day to the close tolerances required to make it work, but...

Sherlock Holmes and Charles Babbage

Ian Malcolm Earlson

These two parts are an introduction to part III, "The Scandal at the Cavendish Card Club," which tells how the great detective outwitted one of Professor Moriarty's agents by using... But why not read it all, in the July-August Creative Computing?

This is an edited version of some notes found in the vaults of the bank of Cox & Co. at Charing Cross. The notes had been placed in a travel-worn and battered tin dispatch-box with the name John H. Watson, M.D. Late Indian Army, painted on the lid and were filed under the heading "Bets, Bails and Babbage."

I. Mycroft Homles Explained

To Sherlock Holmes it was always *the* brain. To the inner circle of Her Majesty's government it was always Mr. Babbage's folly. To you, my dear readers, it was always Mycroft Holmes.

It is generally believed by scholars throughout the world that Charles Babbage's celebrated analytical engine never saw the light of day. Nothing could be further from the truth. The complex and powerful machine was completed late in 1890 largely due to the persuasive powers of Mycroft Holmes and to his personal influence with Her Majesty's government. Sherlock Holmes' brother had for many years used Babbage's earlier difference engine on behalf of the government. Indeed it is safe to say that on more than one occasion Mycroft Holmes rescued the very highest echelons of the government from the brink of disaster by drawing upon the power of Mr. Babbage's first incredible invention. Thus when my colleague's corpulent brother prevailed upon the prime minister for funds to construct the more powerful analytical engine, those funds were readily forthcoming albeit from somewhat mysterious sources. Together with Major General Henry Prevost Babbage, one of the noted scientist's sons who himself wrote a brilliant paper[1] in support of his father's ideas, Sherlock Holmes' elder brother saw the analytical engine through to completion and became the machine's chief and, I believe, sole custodian. As far as I know, the British government never had reason to regret its investment in the new machine.

The analytical engine's existence was a closely guarded secret as indeed was the government's use of its predecessor, the difference engine. As the companion and erstwhile biographer of the great detective, I was a privileged observer to many confidential discussions in which the engines and their use were the subject of hot debate between the brothers Holmes. However, I was under the strictest of orders not to divulge the information which came my way, and I always endeavoured to respect those confidences.

[1]"The Analytical Engine", Proc. of the British Assoc. (1888). (Ed. note: This paper has been reprinted in the book *Charles Babbage and his Calculating Engines*, Philip Morrison and Emily Morrison, ed., Dover, 1961).

But we shall hear again of Mr. Babbage's inventions.

But the computing engines were so intimately tied to Mycroft Holmes and he to them, that it was difficult to discuss one without also interjecting the other into the discussion. Thus I resorted to the literary device of ascribing the engines' attributes and capabilities to the person of Mycroft Holmes in the hope of concealing the existence of the devices themselves. While I was on relatively safe ground in noting that Mycroft Holmes audited the books of the government,[2] my situation became much more precarious when I alluded to "his" great capacity for storing facts and his "brain" in which everything could be pigeonholed and recalled in an instant.[3] The plain fact is that these were descriptions of Babbage's engines and were not characteristics of any human person, much less Sherlock Holmes' brother. None of these poetic liberties evinced any comment from my colleague. But when I was foolhardy enough to say of Mycroft Holmes that "Again and again his word has decided the national policy,"[4] it earned me a strong rebuke.

"In your eagerness to sate your readers' appetites for sensationalism, Watson," Sherlock Holmes said with a severity which betrayed his pique, "you have gravely imperiled the government's position in some delicate negotiations, and you have come dangerously close to compromising Mycroft's position within the government."

"My dear Holmes," I cried in my own defense. "I don't see how—"

"It may surprise you to know," he interrupted, "that most members of the cabinet are totally unaware of the analytical engine's existence. When they read your account of the little affair of the Bruce-Partington Plans, it naturally raised doubts in their minds. Some of the more astute cabinet members have posed questions which could have proved to be of some considerable embarrassment both to my brother and to the prime minister."

"Holmes," I mumbled, completely taken aback by the vehemence of his words and the seriousness of my error, "I had no idea."

"Well, well," he responded in a more sympathetic tone, "it has all been set aright so you are not to worry. But," he added as the sternness returned to his voice, "in future you are on no account to refer to either the analytical engine or to brother Mycroft in your writings."

Thus, my dear readers, you can see why Mycroft Holmes was conspicuous by his absence from the accounts of my friend's adventures. There was little I could say of him without revealing his unique position and endangering the secret of the analytical engine's existence. It was not until quite recently that I was released from my pledge of secrecy.

II. Holmes on the Engines

"I suppose there is little harm in telling the story now," said Holmes as he gazed up at the summer sky of southern England. The occasion was one of my irregular week-end pilgrimages to the Susssex Downs to reminisce with my old friend and colleague. The sun which had been playing upon the heather and the gorse had for the moment disappeared behind a phalanx of ominous looking clouds. Holmes strolled up the gentle slope to the ridge from which one could just discern the White Dover cliffs in the distance. A gentle westerly wind carried the pleasant scent of thyme up from the valley to where we stood together.

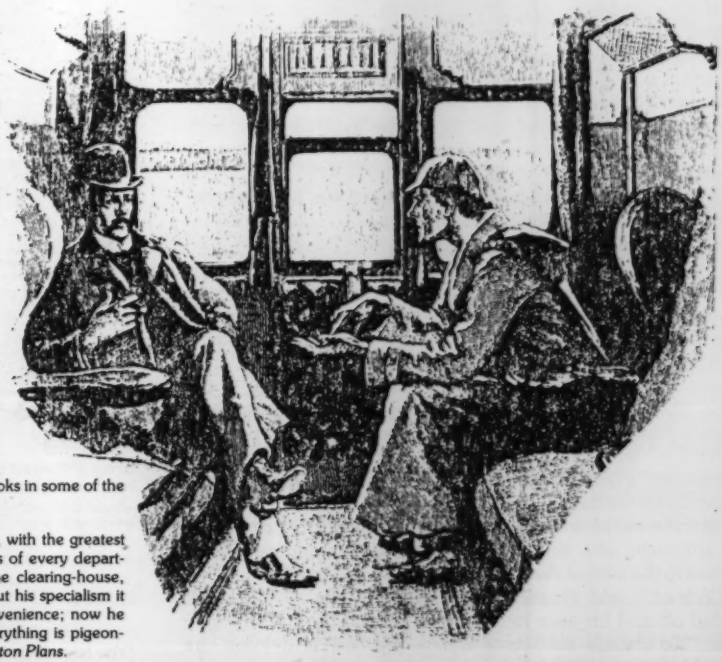
"His Majesty's government has long since lost interest in the machine, and the central characters have passed from sight. Yet I can't refrain from wondering," he added.

"Wondering what?" I asked struggling to keep up with his quickening pace. Retirement, I am happy to report, had diminished neither his physical fitness nor his mental prowess.

Holmes stopped to light his pipe. "Wondering about the machine, Watson, the machine. I cannot believe that we have heard the last of it. True, it had certain drawbacks, not the least of which was the temper of the irrascible Mr. Babbage."

"To say nothing of his son," I continued.

Holmes chuckled. "Even at this ripe old age, Watson, your ability to add a poetic touch has not been diminished."



"I suppose there is little harm in telling the story now," said Holmes.

[2]"He has an extraordinary faculty for figures, and audits the books in some of the government departments." *The Greek Interpreter.*

[3]"He (Mycroft Holmes) has the tidiest and most orderly brain, with the greatest capacity for storing facts, of any man living...The conclusions of every department are passed to him, and he is the central exchange, the clearing-house, which makes out the balance. All other men are specialists, but his specialism it omniscience...They began by using him as a short-cut, a convenience; now he has made himself an essential. In that great brain of his everything is pigeonholed, and can be handed out in an instant." *The Bruce-Partington Plans.*

[4]The Bruce-Partington Plans

Mycroft Holmes

"But we shall hear again of Mr. Babbage's inventions. I think he may have erred by drawing so much attention to the mill. To be sure the mill was, as he implied many, many times, the heart of the machine." His face reflected the intensity of his thoughts. As I watched the firm set of his jaw, the silhouette of his hawk-like nose, the half-closed eyelids; it was as if we were both transported backwards in time to the days when he stood at the head of his profession.

"Mycroft always contended that the store was the most exciting part of the machine, and I am inclined to agree with him. If only one could see how to exploit it."

For some time he stood in silence gazing out over the Downs towards the Channel with a faraway look in his eyes. Then he abruptly sat down upon a large rock formation, leaned forward towards where I was standing, and, using the stem of his pipe as if it were a rapier, said to me, "Look here, Watson. It all comes down to this. The numbers, the data, are kept in the store. but the operations and directives are kept on Mr. Jacquard's punched cards. Now suppose one could place both the operations and directives into the store. Then one could manipulate these instructions for the machine just as one manipulates the data."

"But the mill performs arithmetic," I replied. "How could one do arithmetic with words? What possible meaning can be attached to the sum of the words *multiply* and *divide*?"

"Indeed," said Holmes, "and yet, and yet..." His voice trailed off and his eyes took on that familiar light watery grey cast. "To change the words with a mechanical device?" he mumbled more to himself than to any person. "How?

The intenseness faded from his face almost as quickly as it had come. He leaned back and smiled. "If I were a young man Watson I should certainly turn my energies in that direction."

"Towards mechanical devices?" I asked.

"No, no," Holmes retored with more than a touch of asperity in his voice. Age had done little to mellow his intolerance for those whose minds could not match his own. "Engines, my boy, analytical engines. When they are perfected, as they must be, think of the power they will unleash. It is frightening to contemplate."

I sat down upon the rock opposite as I said, "But the engines are so slow and cumbersome. And so difficult and expensive to construct. Even the great blind mechanic, Von Herder, struggled for years to fit some of the parts. How will one ever make any progress beyon Mr. Babbage's last effort?"

"Well, well, we must hope for some dramatic innovation," Holmes admitted. "It is quite true that the mechanical working parts appear to have reached their ultimate capabilities. But perhaps one can eliminate mechanical parts or at least most of them."

"But how?", I wondered incredulously.

"Ah, there you take me beyond my limits, my boy. I am too old to embark on a new career, attractive as it may be. We must hope that future generations can solve that vexing problems," said my friend as he arose and turned to look back to where his bees were quietly circling their hives.

"Perhaps if you tell the story of Colonel Sebastian Moran and the notorious gambling scandal at the Cavendish card club, it will encourage some young men with a scientific bent to look into analytical engines," he said. His chin had sunk upon his breast. He stood with legs wide apart and his hands thrust into his pockets. "If I could but find the key to the mystery," he murmured. Then he shook his head with a finality of resignation and walked briskly back to his cottage.

Thus it was that I was not only permitted but in a sense encouraged to tell you the tale which follows. Some would call it science fiction, but I assure the reader that it all occurred precisely as I have recorded it. ●

Don't miss part III, "The Scandal at the Cavendish Card Club," in the July-August issue.

"You have come dangerously close to compromising Mycroft's position within the government."

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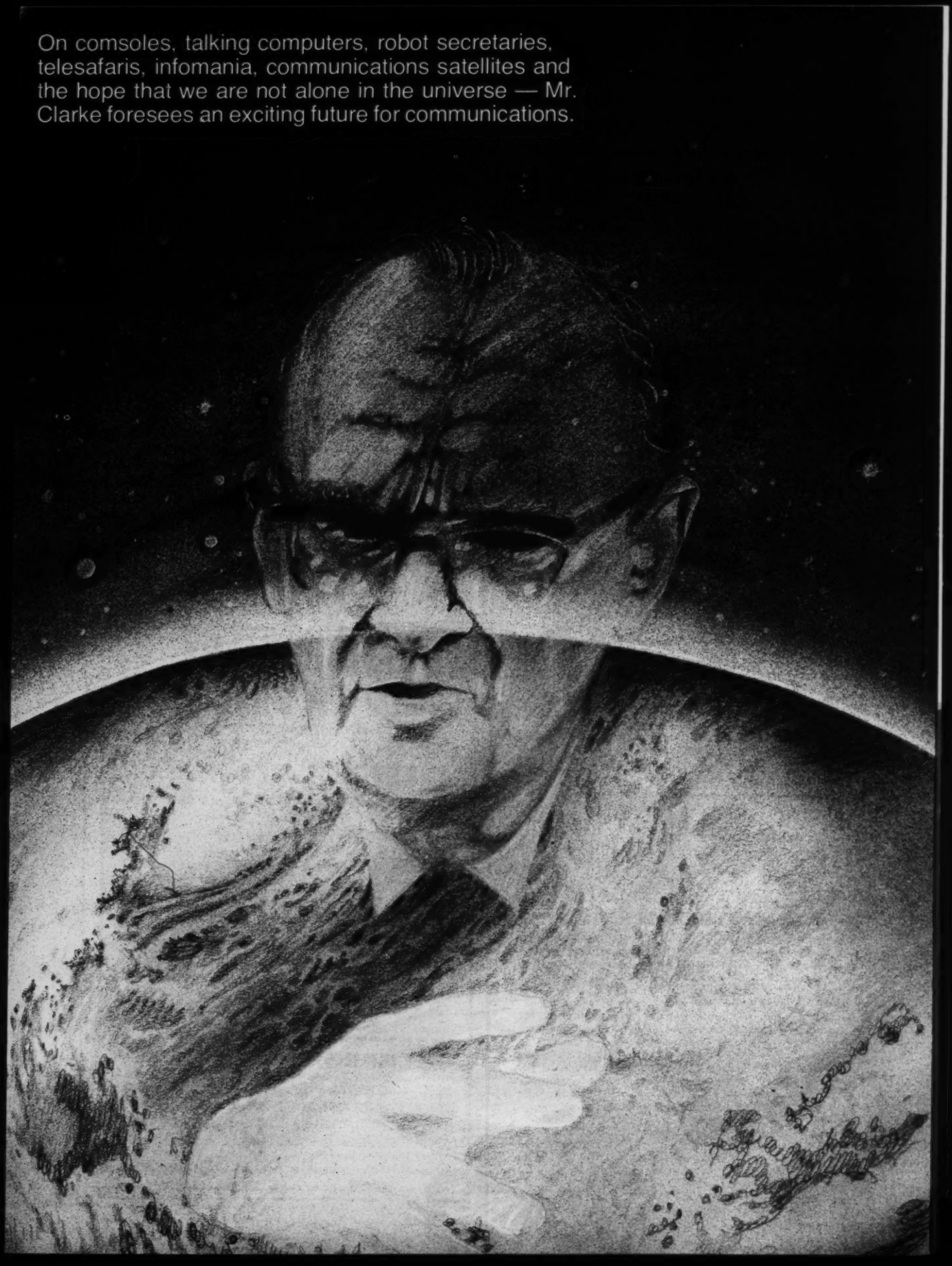

Arthur C. Clarke

Communications in the Second Century of the Telephone

Man is the communicating animal; he demands news, information, entertainment, almost as much as food. In fact, as a functioning human being, he can survive much longer without food — even without water! — than without information, as experiments in sensory deprivation have shown. This is a truly astonishing fact; one could construct a whole philosophy around it.

So any major advance in communications capability that can be conceived can be realized in practice, and that same advance will come into widespread use just as soon as it is practicable. Often sooner; the public can't wait for "state of the art" to settle down. Remember the first clumsy phonographs, radios, tape recorders? And would you believe the date of the first music broadcast? It was barely a year after the invention of the telephone! On April 2, 1877, a "telegraphic harmony" apparatus in Philadelphia sent "Yankee Doodle" to sixteen loudspeakers — well, soft-speakers — in New York's Steinway Hall. Alexander Graham Bell was in the audience, and one would like to know if he complimented the promoter — his now forgotten rival, Elisha Gray, who got to the Patent Office just those fatal few hours too late. . .

Gray was not the only one to be caught out by the momentum of events. When news of the telephone reached England through Cyrus Field's undersea telegraphic cable, the chief engineer of the Post Office was asked whether this new Yankee invention would be of any practical value. He gave the forthright reply: "No, sir. The Americans have need of the telephone — but we do not. We have plenty of messenger boys."

Before you laugh at this myopic Victorian, please ask yourself this question: would you, exactly a hundred years ago, ever dream that the time would come when this primitive toy would not only be in every home and every office, but would be the essential basis of all social, administrative and business life in the civilized world? Or that one day there would be approximately one instrument for every ten human beings on the planet?

Now, the telephone is a very simple device, which even the 19th century could readily mass produce. In fact, one derivative of the carbon microphone must be near the absolute zero of technological complexity: you can make a working — though hardly hi-fi — microphone out of three carpenter's nails, one laid across the other two to form a letter H.

The extraordinary — nay, magical — simplicity of the telephone allowed it to spread over the world with astonishing speed. When we consider the very much more complex devices of the future, is it reasonable to suppose that they too will eventually become features of every home, every office? Well, let me give you another cautionary tale.

The Comfortable Comsole

In the early 1940s, the late John W. Campbell — editor of *Astounding Stories*, and undoubtedly the most formidable imagination ever to be flunked at M.I.T. — poohpoohed the idea of home television. He refused to believe that anything as complex as a TV receiver could ever be made cheap and reliable enough for domestic use.

Public demand certainly disposed of that prophecy. Home TV became available in the Early Neo-Electronic Age — that is, even *before* the solid-state revolution. So let us take it as axiomatic that complexity is no bar to universality. Think of your pocket computers and march fearlessly into the future . . . trying to imagine the ideal, ultimate communications system — the one that would fulfill all possible fantasies.

Since no holds are barred, what about telepathy? Well, I don't believe in telepathy — but I don't *dis*believe in it either. Certainly some form of electronically-assisted mental linkage seems plausible; in fact, this has already been achieved in a very crude form, between men and computers, through monitoring of brain waves. However, I find that *my* mental processes are so incoherent, even when I try to focus and organize them, that I should be very sorry for anyone at the receiving end. Our superhuman successors, if any, may be able to cope; indeed, the development of the right technology might force such an evolutionary advance. Perhaps the best that *we* could manage would be the sharing of emotional states, not the higher intellectual processes. So radio-assisted telepathy might merely lead to some interesting new vices — admittedly, a long-felt want.

Let's stick, therefore, to the recognized sense channels, of which sound and sight are by far the most important. Although one day we will presumably develop transducers for all the senses, just because they are there, I suspect that the law of diminishing returns will set in rather rapidly after the "feelies" and "smellies." These may have

This article was taken from an address by Mr. Clarke at the "Convocation on Communications in Celebration of the Centennial of the Telephone," sponsored by American Telephone and Telegraph Co. and the Massachusetts Institute of Technology.

Drawings by Jerry Dadds

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". . . there are no fundamental scientific obstacles, even to interstellar travel. Though Nobel Laureate Dr. Edward Purcell once rashly remarked that starships should stay on the cereal boxes, where they belonged – that's exactly where moonships were, only 30 years ago. . ."

some limited applications for entertainment purposes, as anyone who was pulverized by the movie *Earthquake* may agree. (Personally, I'm looking forward to the epic *Nova*, in which the theater's heating system is turned on full blast in the final reel. . .)

The basic ingredients of the ideal communications device are, therefore, already in common use even today. The standard computer console, with keyboard and visual display, plus hi-fi sound and TV camera, will do very nicely. Through such an instrument (for which I've coined the ugly but perhaps unavoidable name "comsole" — communications console) one could have face-to-face interaction with anyone, anywhere on earth, and send or receive any type of information. I think most of us would settle for this, but there are some other possibilities to consider.

For example: what about *verbal* inputs? Do we really need a keyboard? I'm sure the answer is "Yes." We want to be able to type out messages, look at them, and edit them before transmission. We need keyboard inputs for privacy, and quietness. A *reliable* voice recognition system, capable of coping with accents, hangovers, ill-fitting dentures and the "human error" that my late friend HAL, the computer from *2001*, complained about, represents something many orders of magnitude more complex than a simple alpha-numeric keyboard. It would be a device with capabilities, in a limited area, at least as good as those of a human brain.

Yet assuming that the curves of the last few decades can be extrapolated, this will certainly be available sometime in the next century. Though most of us will still be tapping out numbers in 2001, I've little real doubt that well before 2076 you will simply say to your comsole: "Get me Bill Smith". Or if you *do* say: "Get me 212-345-5512," it will answer, "Surely you mean 212-345-5521." And it will be quite right.

Now a machine with this sort of capability — a robot secretary, in effect — could be quite expensive. *It doesn't matter.*

Contrary to the edicts of Madison Avenue, the time will come when it won't be necessary to trade in last year's model. Eventually, everything reaches its technological plateau, and thereafter the only changes are in matters of style. This is obvious when you look at such familiar domestic objects as chairs, beds, tables, knives, forks. Oh, you can make them of plastic or fiberglass or whatever, but the basic design rarely alters.

It took a few thousand years to reach these particular plateaus; things happen more quickly nowadays even for much more complex devices. The bicycle took about a century; radio receivers half that time. This is not to deny that marginal improvements will go on indefinitely, but after a while all further changes are icing on a perfectly palatable cake. You may be surprised to learn that there are electrical devices that have been giving satisfactory service for half a century or more. The other day someone found an Edison carbon filament lamp that has apparently never been switched off since it was installed. And until recently, there were sections of Atlantic cable that had been in service for a full century!

Now, it's hard to see how a properly designed and constructed solid-state device can ever wear out. It should have something like the working life of a diamond, which is adequate for most practical purposes. So when we reach this state of affairs, it would be worth investing more in a multi-purpose home communications device than in an automobile. It could be handed on from one generation to the next — as was once the case with a good watch.

Plugging in to the Future

It has been obvious for a very long time that such audio-visual devices could complete the revolution started by the telephone. We are already approaching the point when it will be feasible — not necessarily desirable — for those engaged in what is quaintly called "white-collar" jobs to do perhaps 95 per cent of their work without leaving home. Of course, few of today's families could survive this, but for the moment let's confine ourselves to electronic, not social, technology.

Many years ago I coined the slogan: "Don't commute — communicate!" Apart from the savings in travel time (the *real* reason I became a writer is that I refuse to spend more than 30 seconds moving from home to office) there would be astronomical economies in power and raw materials. Compare the amount of hardware in communications systems, as opposed to railroads, highways and airlines. And the number of kilowatt hours you expend on the shortest journey would power several lifetimes of chatter, between the remotest ends of the earth.

Obviously, the home comsole would handle most of today's first-class mail; messages would be stored in its memory waiting for you to press the playback key whenever you felt like it. Then you would type out the answer — or alternatively call up the other party for a face-to-face chat.

Fine, but at once we have a serious problem — the already annoying matter of time zones. They are going to

become quite intolerable in the electronic global village — where we are all neighbors, but a third of us are asleep at any given moment. The other day I was woken up at 4:00 a.m. by the London *Daily Express*, which had subtracted 5½ hours instead of adding them. I don't know what I said, but I doubt if my views on the Loch Ness Monster were printable.

The railroads and the telegraph made time zones inevitable in the 19th century; the global telecommunications network of the 21st may abolish them. It's been suggested, at least half seriously, that we'll have to establish a Common Time over the whole planet — whatever inconvenience this may cause to those old-fashioned enough to gear themselves to the day-night cycle.

During the course of the day — whatever *that* may be — you will use the home comsole to call your friends and deal with business, exactly as you use the telephone now — with this difference: you'll be able to exchange any amount of tabular, visual or graphical information. Thus if you're an author, you'll be able to wave that horrid page-one type in front of your delinquent editor on Easter Island, or wherever he lives. Instead of spending hours hunting for non-existent parts numbers, engineers will be able to *show* their supplier the broken dohickey from the rotary discombobulator. And we'll be able to see those old friends of a lifetime, whom we'll never again meet in the flesh.

Which raises an interesting problem. One of the great advantages of Mr. Bell's invention is that you can converse with people *without* their seeing you, or knowing where you are, or who is with you. A great many business deals would never be consummated, or even attempted, over a video circuit; but perhaps they are deals that shouldn't be, anyway. . .

I am aware that previous attempts to supply vision — such as the Bell Picturephone — have hardly been a roaring success. But I feel sure that this is due to cost, the small size of the picture, and the limited service available. No one would have predicted much of a future for the very first "Televisors," with their flickering, postage-stamp-sized images. Such technical limitations have a habit of being rather rapidly overcome, and the *large-screen, high-definition* Picturephone-Plus is inevitable.

I could certainly do with such a device. For several years, Stanley Kubrick has been talking wistfully to me about another space project. But there's an insoluble problem — I won't leave my home in Sri Lanka for more than a couple of weeks a year, and Stanley refuses to get into an airplane. We may both be too old, or too lazy, before the arrival of home comsoles makes another collaboration possible. So the present backwardness of electronics has spared the world another masterpiece like *2001: A Space Odyssey*.

Clearly, when we do have two-way vision, there will have to be some changes in protocol. You can't *always* pretend to your wife that the camera has broken down again. . . Incidentally, some of the changes that would be produced in a society totally orientated to telecommunications have been well discussed by a promising local writer, in a novel called *The Naked Sun*. The author's full name escapes me at the moment, but I believe it begins with "Isaac."

Infomaniacs Rejoice!

The possibilities of the comsole as an entertainment and information device are virtually unlimited; some of them, of course, are just becoming available, as an adjunct to the various TV subscription services. At any moment one should be able to call up all the news headlines on the screen, and expand any of particular interest into a complete story at several levels of thoroughness — all the way, let us say, from the *Daily News* to the *New York Times* . . . I hate to think of the hours I have wasted, listening to radio news bulletins — for some item that never turned up. Nothing is more frustrating — as will be confirmed by any Englishmen touring the United States during a Test Match, or any American in England during the World Series (how did it get that ridiculous name?). For the first time, it will be possible to have a news service

"The galaxy must be an absolute Babel of conversation, and it is surely only a matter of time before we can hear the neighbors."

with immediacy, selectivity, *and* thoroughness.

The electronic newspaper, apart from all its other merits, will also have two gigantic ecological plusses. It will save whole forests for posterity; and it will halve the cost of garbage collection. This alone might be enough to justify it, and to pay for it.

Like many of my generation, I became a news addict during World War II. Even now, it takes a definite effort of will for me *not* to switch on the hourly news summaries, and with a truly global service one could spend every waking minute monitoring the amusing, crazy, interesting and tragic things that go on around this planet. I can foresee the rise of even more virulent forms of news addiction, resulting in the evolution of a class of people who can't bear to miss anything that's happening, anywhere, and spend their waking hours glued to the console. I've even coined a name for them — Infomaniacs.

Continuing in this vein, I used to think how nice it would be to have access, in one's own home, to all the books and printed matter, all the recordings and movies, all the visual arts of mankind. But would not many of us be completely overwhelmed by such an embarassment of riches, and solve the impossible problem of selection by selecting nothing? Every day I sneak guiltily past my set of the *Great Books of the Western World*, most of which I've never even opened. . . What would it *really* be like to have the Library of Congress — *all* the world's great libraries — at your fingertips? Assuming, of course, that your fingertips were sufficiently educated to handle the problem of indexing and retrieval. I speak with some feeling on this subject, because for a couple of years I had the job of classifying and indexing everything published in the physical sciences, in all languages. If you can't find what you're looking for in *Physics Abstracts* for 1949-51, you'll know who to blame.

With the latest techniques, it would be possible to put the whole of human knowledge into a shoe box. The problem, of course, is to get it out again; anything misfiled would be irretrievably lost. Another problem is to decide whether we mass-produce the shoe boxes, so that every family has one — or whether we have a central shoe box linked to the home with wide-band communications.

Probably we'll have both, and there are also some interesting compromises. Years ago I invented something that I christened, believe it or not, the *Micropaedia Brittanica*. My *Micropaedia* would be a box about the size of an ordinary hard-cover book, with a display screen and alpha-numeric keyboard. It would contain, in text and pictures, *at least* as much material as a large encyclopaedia plus dictionary.

However, the main point of the electronic *Brittanica* would not be its compactness — but the fact that, every few months, you could plug it in, dial a number, and have it up-dated overnight. . . Think of the saving in wood pulp and transportation that this implies!

The Next Best Thing to Being There . . .

It is usually assumed that the comsole would have a flat TV-type screen, which would appear to be all that is necessary for most communications purposes. But the ultimate in face-to-face electronic confrontation would be when you could not tell, without touching, whether or not the other person was physically present; he or she would appear as a perfect 3-D projection. This no longer appears fantastic, now that we have seen holographic displays that are quite indistinguishable from reality. So I am sure that this will be achieved some day; I am not sure how badly we need it.

What *could* be done, even with current techniques, is to provide 3-D — or at least widescreen Cinerama-type — pictures for a single person at a time. This would need merely a small viewing booth and some clever optics, and it could provide the basis for a valuable educational-entertainment tool, as Dennis Gabor, inventor of holography, has suggested. But it could also give rise to a new industry — personalized television safaris. When you can have a high-quality cinema display in your own home, there will certainly be global audiences for specialized programs with instant feedback from viewer to cameraman. How nice to be able to make a trip up the Amazon, with a few dozen unknown friends scattered over the world, with perfect sound and vision, being able to ask your guide questions, suggest detours, request closeups of interesting plants or animals — in fact, sharing everything except the mosquitoes and the heat!

It has been suggested that this sort of technology might ultimately lead to a world in which no one ever bothered to leave home. The classic treatment of this theme is, of course, E. M. Forster's *The Machine Stops*, written more than 70 years ago as a counterblast to H. G. Wells.

Yet I don't regard this sort of pathological, sedentary society as very likely. "Telesafaris" might have just the opposite effect. The customers would, sooner or later, be inspired to visit the places that really appealed to them. . . mosquitoes notwithstanding. Improved communications will promote travel for *pleasure*; and the sooner we get rid of the other kind, the better.

The Moveable Information Feast

So far, I have been talking about the communications devices in the home and the office. But in the last few decades we have seen the telephone begin to lose its metal umbilical cord, and this process will accelerate. The rise of walkie-talkies and Citizen's Band radio is a portent of the future.

The individual wrist-watch telephone through which you can contact anyone, anywhere, will be a mixed blessing which, nevertheless, very few will be able to reject. In fact, we may not have a choice; it is all too easy to imagine a society in which it is illegal to switch off your receiver, in case the Chairman of the People's Cooperative wants to summon you in a hurry. . . But let's not ally ourselves with those reactionaries who look only on the *bad* side of every new development. Alexander Graham Bell cannot be blamed for Stalin, once aptly described as "Genghis Khan with a telephone."

It would be an *underestimate* to say that the wrist-watch telephone would save tens of thousands of lives a year. Everyone of us knows of tragedies — car accidents on lonely highways, lost campers, overturned boats, even old people at home — where some means of communication would have made all the difference between life and death. Even a simple emergency S.O.S. system, whereby one pressed a button and sent out a HELP! signal, would be enough. This is a possibility of the immediate future; the only real problem — and, alas, a serious one — is that of false alarms.

Now, the invariably forgotten accessory of the wrist-watch telephone is the wrist-watch telephone *directory*. Considering the bulk of that volume for even a modest-sized city, this means that our personal transceivers will require some sophisticated information-retrieval circuits, and a memory to hold the few hundred most-used numbers. So we may be forced, rather quickly, to go the whole way, and combine in a single highly portable unit not only communications equipment, but also something like today's pocket-calculators, plus data banks, plus information processing circuits. It would be a constant companion, serving much the same purpose as a human secretary. In a recent novel I called it a "Minisec." In fact, as electronic intelligence develops, it would provide more and more services, finally developing a personality of its own, to a degree which may be unimaginable today.

Except, of course, by science fiction writers. In his brilliant novel, *The Futurological Congress*, Stanislaw Lem gives a nightmare cameo which I can't get out of my mind. He describes a group of women sitting in complete silence — while their handbag computers gossip happily to one another. . .

Tiptoeing Through the Spectrum

At this point, before I lose all credibility with the hairy-knuckled engineers who have to produce the hardware, I'd better do a once-over-lightly of the electromagnetic spectrum. This is, I think, unique among our natural resources. We've been exploiting it for less than one lifetime, and are now polluting much of it to the very maximum of our ability. But if we stopped using it tomorrow, it would be just as good as new, because the garbage is heading outwards at the speed of light. . . Too bad this isn't true of the rest of the environment.

Do we have enough available bandwidth for a billion personal transceivers, even assuming that they aren't all working at once? As far as the home equipment is concerned, there is no problem, at least in communities of any size. The only uncertainty, and a pretty harrowing one to the people who have to make the decisions, is how quickly coaxial cables are going to be replaced by glass fibers, with their million-fold greater communications capability. Incidentally, one of the less glamorous occupations of the future will be mining houses for the rare metal, copper, buried inside them by our rich ancestors. Fortunately, there is no danger that we shall ever run out of silica. . .

But I would also suggest that optical systems, in the infrared and ultraviolet, have a great future not only for fixed, but even for *mobile*, personal communications. They may take over some of the functions of present-day transistor radios and walkie-talkies — leaving the radio bands free for services which can be provided in no other way. The fact that opticals have only very limited range, owing to atmospheric absorption, can be turned to major advantage. You can use the same frequencies — and *what* a band of frequencies! — millions of times over — as long as you keep your service areas 10 or 20 kilometers apart.

It may be objected that light waves won't go round corners, or through walls. Elementary, my dear Watson. We simply have lots of dirt cheap — because they are

made from dirt! — optical wave guides and light pipes deliberately leaking radiation all over the place. Some would be passive, some active. Some would have very low-powered optical-to-radio transducers in both directions, to save knocking holes in walls, and to get to awkward places. In densely populated communities one would always be in direct or reflected sight of some optical transmitter or repeater. But we must be careful how we use the ultraviolet. People who talked too much might get sunburned. . .

When you are cycling across Africa, or drifting on a balsa-wood raft across the Pacific, you will of course still have to use the radio frequencies — say the one to ten thousand megahertz bands, which can accomodate at least ten million voice circuits. This number can be multiplied many times by skillful use of satellite technology. I can envisage an earth-embracing halo of low-altitude, low-powered radio satellites, switching frequencies continually so that they provide the desired coverage in given geographical regions. And N.A.S.A. has recently published a most exciting report on the use of the very large (kilometer-square!) antennas we will soon be able to construct in space. These would permit the simultaneous use of myriads of very narrow beams which could be focused on individual subscribers carrying receivers which could be mass-produced for about $10. I rather suspect that our long-awaited personal transceiver will be an adaptive, radio-optical hybrid, actively hunting the electromagnetic spectrum in search of incoming signals addressed to it.

The Electronic Drug?

One of the functions of science fiction is to serve as an early warning system. In fact, the very act of description may prevent some futures, by a kind of exclusion principle. Far from predicting the future, science fiction often *exorcises* it. At the very least, it makes us ask ourselves: "What kind of future do we really want?" No other type of literature poses such fundamental questions, at any rate explicitly.

The marvellous toys that we have been discussing will simply remain toys, unless we use them constructively and creatively. Now, toys are all right in the proper place; in fact they are an essential part of any childhood. But they should not become mere distractions — or ways of drugging the mind to avoid reality.

We have all seen unbuttoned beer-bellies slumped in front of the TV set, and transitorized morons twitching down the street, puppets controlled by invisible disk jockeys. These are not the highest representatives of our culture; but, tragically, they may be typical of the near future. As we evolve a society orientated towards information, and move away from one based primarily on manufacture and transportation, there will be millions who cannot adapt to the change. We may have no alternative but to use the lower electronic arts to keep them in a state of drugged placidity.

For in the world of the future, the sort of mindless labor that has occupied 99 per cent of mankind, for much more than 99 per cent of its existence, will of course be largely taken over by machines. Yet most people are bored to death without work — even work that they don't like. In a workless world, therefore, only the highly educated will be able to flourish, or perhaps even to survive. The rest are likely to destroy themselves and their environment out of sheer frustration. This is no vision of the distant future; it is already happening, most of all in the decaying cities.

So perhaps we should not despise TV soap operas if, during the turbulent transition period between our culture and real civilization, they serve as yet another opium for the masses. *This* drug, at any rate, is cheap and harmless, serving to kill time — for those many people who like it better dead.

Communicate to Educate

When we look at the manifold problems of our age, it is clear that the most fundamental one — from which almost all others stem — is that of ignorance. And ignorance can be banished only by communication, in the

"We are now in the early stages of a battle for the mind . . . of the human race, a battle which will be fought 36,000 kilometers above the equator."

widest meaning of the word.

The best educational arrangement, someone once remarked, consists of a log with a teacher at one end and a pupil at the other. Unfortunately there are no longer enough teachers, and probably not enough logs, to go around.

Now, one thing that electronics can do rather well is to multiply teachers. As you doubtless know, at this very moment a most ambitious and exciting social experiment is taking place in India, where N.A.S.A.'s ATS-6 satellite is broadcasting educational programs to several thousand villages. ATS-6 is the only communications satellite in existence powerful enough to transmit signals that can be picked up on an ordinary TV set, augmented by a simple parabolic dish, like a large umbrella made of wire mesh.

Thanks to the extraordinary generosity of the Indian Space Research Organization, which flew in six engineers and half a ton of equipment, I have a five-meter satellite antenna on the roof of my Colombo house, now renamed "Jodrell Bank East." Since the experiment started on August 1, 1975, I have thus been in the curious position of having the only TV set in Sri Lanka. It's been fascinating to watch the programs; even though I don't understand Hindi, the messages of family planning, hygiene, agricultural techniques and national unity come across loud and clear.

Though it is impossible to put a value on such things, I believe that the cost of this experiment will be trivial compared with the benefits. And the ground segment is remarkably cheap, in terms of its coverage. Would you believe 4,000 people round one TV set? Or a 3-meter-diameter village antenna — made of *dried mud*?

Of course, there are some critics — as reported recently by Dr. Yash Pal, the able and energetic Director of the Indian Space Application Centre:

"In the drawing rooms of large cities," he says, "you meet many people who are concerned about the damage one is going to cause to the integrity of rural India by exposing her to the world outside. After they have lectured you about the dangers of corrupting this innocent, beautiful mass of humanity, they usually turn round and ask: 'Well, now that we have a satellite, when are we going to see some American programs?' Of course they themselves are immune to cultural domination or foreign influence."

I'm afraid that cocktail party intellectuals are the same everywhere. Because *we* frequently suffer from the modern scourge of information pollution, we find it hard to imagine its even deadlier opposite — information starvation. For any outsider, however well-meaning, to tell an Indian villager that he would be better off without access to the world's news, entertainment, *and knowledge*, is an obscene impertinence, like the spectacle of a fat man preaching the virtues of fasting to the hungry.

Unfortunately, on July 31, 1976, the one-year experiment will end; ATS-6 will crawl back along the equator and return to the United States. Originally, it was hoped to launch *two* satellites; last summer I saw the three-quarters completed ATS-7, sitting mothballed at the Fairchild plant. No one could raise the $10 million necessary to finish it, or hijack one of the Air Force's numerous Titan 3-Cs to get it into orbit.

And so in a few months' time, millions of people who have had a window opened on marvellous new worlds of culture and education will have it slammed in their faces again. There will be some heart-rending scenes in the villages, when the cry goes up, however unfairly, "The Americans have stolen our satellite!" Useless to explain, as the frustrated viewers start to refill their six-to-nine p.m. time slot with baby-making, that it was only through the initiative and generosity of the United States that the satellite was loaned in the first place. . . The Ugly American will have struck again.

Yet I hope that this noble experiment is just the curtain-raiser to a truly global educational satellite system. Its cost would be one or two dollars per student, per *year*. There could be few better investments in the future health, happiness and peace of mankind.

I don't wish to get too much involved in the potential — still less the politics — of communications satellites, because they can take care of themselves, and are now multiplying rapidly. The world investment in satellites and ground stations now exceeds a billion dollars, and is increasing almost explosively. After years of delay and dithering, the United States is at last establishing *domestic* satellite systems; the U.S.S.R. has had one for almost a decade. At first, the Soviet network employed *non*-synchronous satellites, moving in an elongated orbit that took them high over Russia for a few hours of every day. However, they have now seen the overwhelming advantages of stationary orbits, and several of their comsats are currently fixed above the Indian Ocean. Some are designed for TV relaying to remote parts of the Soviet Union, and I've gently hinted to my friends in Moscow that perhaps *they* could fill the breach when ATS-6 goes home. . .

We are now in the early stages of a battle for the mind — or at least the eyes and ears — of the human race, a battle which will be fought 36,000 kilometers above the

equator. The preliminary skirmishes have already taken place at the United Nations, where there have been determined attempts by some countries to limit the use of satellites which can beam programs from space directly into the home, thus bypassing the national networks. Guess who is scared. . .

As a matter of fact, I tried to frighten the United States with satellites myself, back in 1960, when I published a story in 1960 in *Playboy* about a Chinese plot to brainwash innocent Americans with pornographic TV programs. Perhaps "frighten" is not the correct verb, and in these permissive days such an idea sounds positively old-fashioned. But in 1960 the first regular comsat service was still five years in the future, and this seemed a good gambit for attracting attention to its possibilities.

United States of Earth

Fortunately, in this area there is an excellent record of international cooperation. Even countries who hate each other's guts work together through the International Telecommunications Union, which sets limits to powers and assigns frequencies. Eventually, some kind of consensus will emerge, which will avoid the worst abuses.

A major step towards this was taken on August 20, 1971, when the agreement setting up INTELSAT (the International Telecommunications Satellite Organization) was signed at the State Department. I would like to quote from the address I gave on that occasion:

"I submit that the eventual impact of the communications satellite upon the whole human race will be at least as great as that of the telephone upon the so-called developed societies.

"In fact, as far as real communications are concerned, there are as yet no developed societies; we are all still in the semaphore and smoke-signal stage. And we are now about to witness an interesting situation in which many countries, particularly in Asia and Africa, are going to leapfrog a whole era of communications technology and go straight into the space age. They will never know the vast networks of cables and microwave links that this country has built at such enormous cost both in money and in natural resources. The satellites can do far more and at far less expense to the environment. . .

". . .I believe that the communications satellites can unite mankind. Let me remind you, that, whatever the history books say, this great country was created a little more than a hundred years ago by two inventions. Without them, the United States was impossible; with them, it was inevitable. Those inventions were, of course, the railroad and the electric telegraph.

"Today we are seeing on a global scale an almost exact parallel to that situation. What the railroads and the telegraph did here a century ago, the jets and the communications satellites are doing now to all the world. . ."

And the final result — whatever name we actually give to it — will be the United States of Earth.

The Space Barrier

I would like to end with some thoughts on the wider future of communications — communications beyond the earth. And here we face an extraordinary paradox, which in the centuries to come may have profound political and cultural implications.

For the whole of human history, up to that moment one hundred years ago when the telephone was invented, it was impossible for two persons more than a few meters apart to interact in real time. The abolition of that apparently fundamental barrier was one of technology's supreme triumphs; today we take it for granted that men can converse with each other, and even see each other, wherever they may be. Generations will live and die, always with this godlike power at their fingertips.

Yet this superb achievement will be ephemeral; before the next hundred years have passed, our hard-won victory over space will have been lost, never to be regained.

On the Apollo voyages, for the first time, men traveled more than a light-second away from earth. The resulting two-and-a-half second round-trip communications delay was surprisingly unobtrusive, but only because of the dramatic nature of the messages — and the discipline of the speakers. I doubt if the average person will have the self-control to talk comfortably with anyone on the moon.

And beyond the moon, of course, it will be impossible. We will never be able to converse with friends on Mars, even though we can easily exchange any amount of information with them. It will take at least three minutes to get there, and another three minutes to receive a reply.

Anyone who considers that this is never likely to be of much practical importance is taking a very short-sighted view. It has now been demonstrated, beyond reasonable doubt, that in the course of the next century, we could occupy the entire solar system. The resources in energy and material are there; the unknowns are the motivation — and our probability of survival, which may indeed depend upon the rate with which we get our eggs out of this

one fragile planetary basket.

We would not be here, talking about the future, unless we were optimists. And in that case we must *assume* that eventually very large populations will be living far from earth — light-minutes and light-hours away, even if we colonize only the inner solar system. However, space colony advocate Freeman Dyson has argued with great eloquence that planets aren't important, and the real action will be in the cloud of comets out beyond Pluto, a light-*day* or more from earth.

And looking further afield, it is now widely realized that there are no *fundamental* scientific obstacles even to interstellar travel. Though Nobel Laureate Dr. Edward Purcell once rashly remarked that star-ships should stay on the cereal boxes, where they belonged — that's exactly where moonships were, only 30 years ago. . .

So the finite velocity of light will, inevitably, divide the human race once more into scattered communities, sundered by barriers of space and time. We will be as one with our remote ancestors, who lived in a world of immense and often insuperable distances, for we are moving out into a universe vaster than all their dreams.

Are There Others?

But it is, surely, not an empty universe. No discussion of communications and the future would be complete without reference to the most exciting possibility of all — communications with extra-terrestrial ingelligence. The galaxy must be an absolute Babel of conversation, and it is surely only a matter of time before we can hear the neighbors. They already know about us, for our sphere of detectable radio signals is now scores of light-years across. Perhaps even more to the point — and more likely to bring the precinct cops hurrying here as fast as their paddy-wagon can travel — is the fact that several microsecond-thick shells of x-ray pulses are already more than ten light-years out from earth, announcing to the universe that, somewhere, juvenile delinquents are detonating atom bombs.

Plausible arguments suggest that our best bet for interstellar eavesdropping would be in the 1000-Megahertz, or 30 centimeter, region of the spectrum. The N.A.S.A./Stanford/Ames *Project Cyclops* report, which proposed an array of several hundred large radio telescopes for such a search, recommended a specific band about 200 Megahertz wide — that lying between the hydrogen line (1420 MHz) and the lowest OH line (1,662 MHz). Dr. Bernard Oliver, who directed the *Cyclops* study, has waxed poetic about the appropriateness of *our* type of life seeking its kind in the band lying between the disassociation products of water — the "water-hole."

Unfortunately, we may be about to pollute the water-hole so badly that it will be useless to radio astronomers. The proposed MARESAT and NAVSTAR satellites will be dunked right in the middle of it, radiating so powerfully that they would completely saturate any *Cyclops*-type array. Barney Oliver tells me: "Since the *Cyclops* study, additional reasons have become apparent for expecting the water-hole to be our contact with the mainstream of life in the galaxy. The thought that we, through our ignorance, may blind ourselves to such contact and condemn the human race to isolation appalls us."

I hope that the next World Administrative Radio Conference, when it meets in 1979, will take a stand on this matter. The conflict of interest between the radio astronomers and the communications engineers will get more and more insoluble, until, as I suggested many years ago, we move the astronomers to the quietest place in the solar system — the center of the lunar farside, where they will be shielded from the radio racket of earth by 3,500 kilometers of solid rock. But *that* answer will hardly be available before the next century.

Whatever the difficulties and problems, the search for extra-terrestrial signals will continue. Some scientists fear that it will not succeed; others fear that it *will*. It may already have succeeded, but we don't yet know it. Even if the pulsars *are* neutron stars — so what? They may still be artificial beacons, all broadcasting essentially the same message: "Last stop for gas this side of Andromeda."

More seriously, if the decades and the centuries pass, with no indication that there is intelligent life elsewhere in the universe, the long-term effects on human philosophy will be profound — and may be disastrous. Better to have neighbors we don't like, than to be utterly alone. For that cosmic loneliness could point to a very depressing conclusion — that intelligence marks an evolutionary dead-end. When we consider how well — and how *long* — the sharks and the cockroaches have managed without it, and how badly we are managing *with* it, one cannot help wondering if intelligence is an aberration like the armor of the dinosaurs, dooming its possessors to extinction.

No, I don't *really* believe this. Even if the computers we carry on our shoulders are evolutionary accidents, they can now generate their own programs — and set their own goals.

For we can now say, in the widest possible meaning of the phrase, that the purpose of human life is information processing. I have already mentioned the strange fact that men can survive longer without water than without information. . .

And therefore the real value of all the devices we have been discussing is that they have the potential for immensely enriching and enlarging life, by giving us more information to process — up to the maximum number of bits per second that the human brain can absorb.

I am happy, therefore, to have solved one of the great problems the philosophers and theologians have been haggling over for several thousand years. You may, perhaps, feel that this is rather a dusty answer, and that not even the most inspired preacher could ever found a religion upon the slogan: "The purpose of life is information processing." Indeed, you may even retort: "Well, what is the purpose of information processing?"

I'm glad you asked me that. . . ●

Arthur C. Clarke is author of numerous popular works of science fiction and science fact, including the book and movie *2001: A Space Odyssey*, and his latest novel, *Imperial Earth* (Harcourt, Brace, Jovanovich, 1975). He is also credited with conceiving the idea of the communications satellite. Says Mr. Clarke, "Back in 1943, as an extremely callow officer in the Royal Air Force, I was given a mysterious assignment to a fog-shrouded airfield at the southwestern tip of England.

"It turned out I was to work with an eccentric group of Americans from something called the Radiation Laboratory of the Massachusetts Institute of Technology. They were led by a bright young physicist named Luis Alvarez, who had invented a radar device that, for a change did something useful. It could bring down an aircraft in one piece, instead of several.

"Luis' brainchild provided me with the peaceful environment, totally insulated from all the nasty bombings and invasions happening elsewhere, which allowed me to work out the principles of communications satellites in the spring of 1945."

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Reviews Editor: John Lees
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Readers: Want to be a reviewer? Write to the Reviews Editor directly. Publishers: send material for review to the Reviews Editor.

Background Math For A Computer World. Ruth Ashley. John Wiley & Sons, Inc., 605 Third Ave., New York, NY 10016. 286 pp., paperback. $3.95. 1973.

This book is one in a series of Wiley Self-Teaching Guides. The format of the book is programmed instruction. Each chapter is divided into individual frames of instruction with their own questions to check on the reader's comprehension of the text material presented. Each chapter concludes with a self test on the contents of the chapter. The book concludes with a final test on all the material in the book. Answers to all questions are provided in the text.

The author intends the book "for the tens of thousands of people who find that their lives are being increasingly affected by computers. It is for the students with no college math and very limited high school mathematics who discover that they, too, are expected to be able to use computers — in business, in psychology, in education, in the social sciences."

The first two chapters concern themselves with the binary, octal, and hexadecimal number system. Operations within, and conversion between these systems are covered. I would not think that these topics are important to the type of person who would be using this text. The third chapter concerns itself with logic for computers. Conjunctions, disjunctions, negations, implications, De Morgan's Rules, and truth tables are some of the topics considered. The fourth chapter deals with being able to follow, but not write, a flowchart. Chapter 5 covers integer arithmetic, floating-point arithmetic, scientific notation (E-notation), and operations in E-notation. The last seven chapters are separated into the following seven topics: Interest and Mortgage Problems, Sequence and Series, Probability, Statistics, Linear Equations, Matrix Algebra, and Game Theory. Some of these later chapters, such as the chapter on Statistics, do not explain concepts well, and so it becomes a matter of accepting certain formulas on faith. I feel that the chapters on Logic and Interest and Mortgage Problems are the best in the book.

It is hard to think of this book being suitable for "tens of thousands of people." It may be helpful to some college students majoring in the humanities who find themselves exposed to the computer, but only a subset of the chapters would prove helpful. Another possible use for the book would be as a supplement to a programming book in an adult education or equivalent course.

Bruce W. De Young
Oakland, New Jersey

Computing with Mini-Computers. Fred Gruenberger and David Babcock. Melville Publishing Company, Los Angeles, California, 288 pp. $13.75. 1973.

The authors' effort to provide an introduction and overview in the first few chapters of *Computing with Mini-Computers* makes an attempt to define a mini-computer based on size and cost. However, in the three years since the publication of this text, there have been many changes in the mini field. A mini-computer is defined in the text in terms of three variables — storage capacity, top speed, and operation-code repertoire. In spite of the fact that physical parameters are the least important, the authors go on to describe the mini in terms of its physical size. However, mini-computers have been configured in a variety of ways which greatly exceed the physical dimensions provided in the book. The examples utilized throughout the text are for a Varian machine, even though it is pointed out that Digital Equipment Corporation both produces and sells the largest number of mini-computers. There are some commonalities between mini-computers. However, the differences exceed the parameters defined in this text.

The chapters on flow-charting are relatively standard and can be found in other texts. The book uses a problem-solving approach so that the reader is led through a series of problems that require computer solutions. Lack of access to a mini-computer might be a limiting factor for many potential readers who are interested in the field of minis but do not have access to such equipment. Although the book is well developed, it discusses material that can be found in many other texts. It is the opinion of this reviewer that the textbook has only limited utility for individuals interested in mini-computers since the state of the art has changed drastically since 1973. There is virtually no discussion of micro-programming units which may or may not be classified as mini-computers. The basic and historical information contained in the book is of some value and the conceptual information on indexing, sub-routining and sequencing of program statements can be applied to a variety of situations. The chapter on testing and de-bugging of programs is relatively standard. The eight-page glossary of computer terminology is fairly complete for 1973. However, it lacks comprehensiveness for modern mini-computing. I would recommend the book with reservation for individuals who are interested in mini-computers as a fair resource and entree to some of the more current literature found in the periodicals.

Daniel Krautheim
Columbus, Ohio

Finite State Fantasies. Rich Didday. Matrix Publishers, 207 Kenyon Road, Champaign, Illinois 61820. 50pp., $2.25, 1976.

Finite State Fantasies is a comic book devoted to visual communication of computer user situations. About half the booklet explains how the computers work. This part is good for anyone who would like to develop an understanding of computer hardware.

The other half of the booklet involves pictorial representation of common computer user occurences: bugs, glitches, and computer obsession. Interspersed in the booklet are several one-page cartoon series.

The booklet can be understood by someone of any age group or computer background. The graphics are nicely done. The book is a nice addition to the field of fun computer books and it would make a nice gift.

Dennie Van Tassel
Santa Cruz, California

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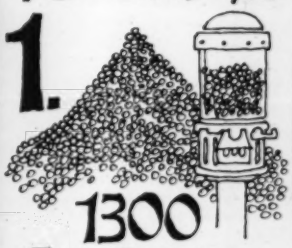

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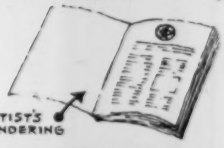

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ALGOL 60 and FORTRAN IV. Rbin A. Vowels. John Wiley and Sons Australasia Pty. Ltd., Box 152, N. Ryde, N.S.W. 2113. 173 pp., paper. $4.95. 1975.

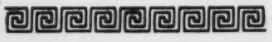
The author provides an "introduction to programming via the ALGOL or FORTRAN languages at the undergraduate level." This side-by-side presentation of elementary ALGOL 60 and FORTRAN IV is unique in that the book is not intended to be a comparative study of the two languages. Instead, it is intended that the reader learn ALGOL 60 or FORTRAN IV as well as the fundamentals of programming language concepts such as program structure, syntax, expressions, loops, control statements, and subroutines. Once proficient in one language, the reader can assimilate the other mainly by a comparison of the text's examples.

There are seven chapters: Overview of ALGOL and FORTRAN; Assignments and Declarations; Input-Output; Control Statements and Loops; *for* Clause, DO Statements, Subscripted Variables; Subroutines and Blocks; More FORTRAN Input-Output. There are appendices on ALGOL and FORTRAN Implementations, Representations of ALGOL Symbols, Supplied Functions, and a Bibliography.

This paperback is suitable as an ALGOL 60 or FORTRAN IV primer which emphasizes numeric examples and exercises. There are many references to machine characteristics and ALGOL on the ICL System 4-50, ICL 1900 Series, the CYBER 70 System. ALGOL W is also mentioned. Statement types and programming techniques are illustrated by short examples and a few case studies.

The book would make a suitable supplement for a course emphasizing computers, computing, and algorithm development exclusive of programming.

John L. Lowther
Houghton, Mich.



LOGLAN 1: A Logical Language, Third Edition, by James C. Brown, 300 pages, 1975.
LOGLAN 4&5: A LOGLAN-ENGLISH/ENGLISH-LOGLAN Dictionary, Second Edition, by James C. Brown, 510 pages, 1975. The Logland Institute, Inc., P.O. Box 12458, University Station, Gainesville, Florida, 32604, P.O. Box 1785, Palm Springs, California, 92262.

The dedication of *LOGLAN 1* reads: "To the memory of Benjamin Lee Whorf." Loglan is a constructed human language, originally devised to test the Sapir-Whorf hypothesis that the structure of a person's language determines the bounds of that person's thought. Under development since 1955, Loglan is an attempt to provide a laboratory tool in the form of a small language which can be used in linguistical experimentation.

The name 'Loglan' is taken from 'logical' and 'language.' Loglan is logical in the sense that it has a hyperlogical structure, which it was given on purpose to make it functionally different from the natural languages. This does not mean that Loglan is a deductive system such as formal logic, for "Loglan is logical only in the sense of purporting to facilitate certain limited kinds of thought: namely those kinds which proceed by the transformation of sentences into other sentences in such a way that if the first are true so also are the second."

If you are at all interested in linguistics, these are fascinating publications. Aside from its intended use, Loglan is simply fun to play with, as Brown points out in a section on Loglan as a Linguistic Toy. Learning a new language is usually said to help one see the world through the eyes of another people by giving access to another culture. Loglan is a language without a culture. The Sapir-Whorf hypothesis is that your view of the world and your way of thinking should change simply from learning and using Loglan.

John Lees
Rolla, MO

A Practical Guide to Algol 68. Frank G. Pagan. John Wiley & Sons, Ltd., Baffins Lane, Chichester, Sussex, Eng. 213 pp. $9.50. 1976.

This delightful little book provides perhaps the best and most readable presentation of ALGOL 68 for anyone wishing to gain a working knowledge of the language. Pagan's book is "an informal but comprehensive guide to the final (1974) version of the ALGOL 68 programming language."

ALGOL 68 is an elegant general purpose programming language of wider applicability than ALGOL 60 and comparable in power to PL/I. It was designed for use in many application areas as well as for use as a reference and publication language. Just as ALGOL 60 contributed to the theoretical development of programming language concepts and implementation techniques, so will ALGOL 68.

The author has used structured programming in his exposition and his examples in order to systematically develop "the basic techniques of writing correct and understandable program." (The *goto* is not introduced until the last chapter!)

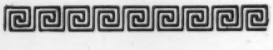
There are eight chapters: Basic Concepts and Constructs; Straight-line Programs; Loops and Multiple Values; Conditional Elaboration; Routines; Extended Modes; Transput; and Additional Control Devices. In addition, there are answers to exercises, two appendices, selected bibliography, and an index.

Some ALGOL 68 texts and reports are very unpleasant to read, primarily because the designers of ALGOL 68 introduced many new technical terms. Pagan consistently uses terms found in the official ALGOL 68 language definition, but correlates those terms with terminology of other languages and uses ALGOL 68 terms in a very pleasing and readable fashion.

Another feature of the book is the identification of sections and examples on particular language features: non-numeric, commercial, and numeric. Chapter 6, Extended Modes, provides an excellent discussion on extensibility mechanisms in ALGOL 68 such as the creation of new modes or datatypes, programmer defined data structures, and new operators.

The book is enthusiastically recommended to "anyone wishing to gain a practical knowledge of ALGOL 68, including those with no previous programming experience." Perhaps this statement by the author is true only for university level readers with some mathematical background. For other readers, it is advisable to have experience in at least one other programming language. The book is excellent even for those who have no access to an implementation of ALGOL 68. Finally, perhaps those readers who wish to study the more technical ALGOL 68 reports, may find those studies made easier by first reading Pagan's guide to ALGOL 68.

John L. Lowther
Houghton, Mich.



Computer Problem Solving. R.P. Watkins, John Wiley and Sons Australasia Pty Ltd., Sidney, 162 pp., $9.95, 1974.

Watkins discusses problem solving using algorithms, flow charts and heuristics. He then discusses some problems in handling computer files, sorting and simulations.

The chapter on algorithms and flowcharting is well done and excellent reading for any math student. The chapter on heuristics is also well done, the examples used not only thought provoking but could be carried to about any extreme that the reader cares to go. The section on sorting (nine and a half ways of sorting) is a good example of the many ways a job can be done and the finesse necessary for a good programmer.

An excellent book.

Elwin E. Young

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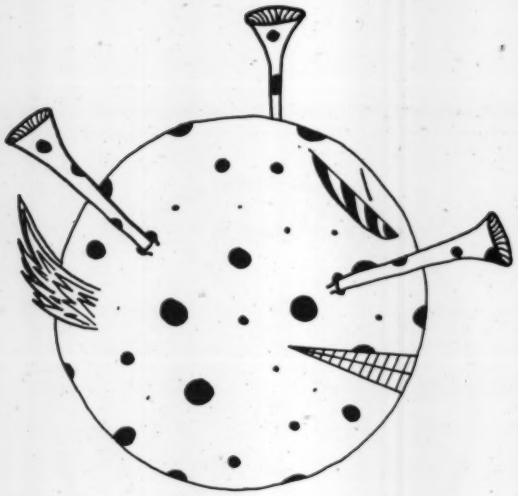
TWONKY

by Mark Capella



Game Set-Up:

The computer will set up a 15x15 playing field in which you are randomly located. Also inside the field is an objective square, 30 blocked squares (walls), 22 relocation squares, and 1 super special new maze square, and, of course, the Twonky (which is no relation to a creme-filled cupcake).

Basic Playing Instructions:

To win the game, you must reach the objective square before the Twonky gets you, by moving one square at a time, forward, backward, right or left. Unfortunately, you are hindered by several things:

RELOCATION squares, when moved on, cause you to be randomly transported to another position in the maze.

WALLS; you can't move into these squares, and lose your turn when you hit one.

SUPER-MAZE-SQUARE; essentially an instant loss, since when you move here a completely new maze is set up.

TWONKY; after every move, the Twonky moves toward you. (He is impervious to all traps, even walls). When he gets too close to you (2 or fewer squares), you lose. However, you are equipped with a de-materializing ray gun. You have the option of using this on your turn. If you hit the Twonky he de-materializes and then re-materializes on a different square of the maze to resume his quest after you. (CAUTION: he could be dropped into your lap!).

After each move pair (you and Twonky), your distance from both the Twonky and the objective square are printed. There is no board printout — you play blind. However, using the distances, you can home in to the approximate position of both Twonky and objective.

Hints and Advanced Techniques:

When shooting at the Twonky, you do *not* have a shot if the distance he is from you is not an integer. For example: If the Twonky is 2.23606 units away, you don't have a direct shot. If he is 4 units away, you do have a shot. Exceptions to this rule are distances of 5, 10, 13, and 17. (A review of the Pythagorean Theorem will show why this is true.) Hence, if the distance is 5, 10, or 13 (but not 17), you may or may not have a direct shot. Likewise, this set of rules applies to the direction of the objective.

If you watch your distances before and after moving, you should be able to tell where the Twonky is in relation to you, e.g., forward and to the right, or backward and to the left. Take the distance you are from the Twonky, square it, say $2.23606^2 = 4.999998$ approx. = 5. Then find two integers that when squared and added together equal this (2 and 1). If the Twonky is forward and to the right, you now know that he is either up 2, over 1, or up 1, over 2.

Comments:

The thing that makes Twonky unique, is that it can be played on two levels, one in which you play for fun, moving haphazardly; or you can play while figuring out exact positions, and calculating moves in advance for a challenging (as well as fun) game.

Mark Capella can be reached at 7278 Oswego Road, Liverpool, NY 13088.

```
100 REM *** MARK CAPELLA - LIVERPOOL HIGH, SYRACUSE
110 REM *** WRITTEN ON OCT. 1975
120 REM *** UPDATED ON NOV. 1976 AT
130 REM *** ROCHESTER INSTITUTE OF TECHNOLOGY
140 GOSUB 2250
150 DIM A(15,15)
160 LET R9=0
170 GOSUB 1830
180 PRINT"--------------------------------------"
190 PRINT
200 GOSUB 1450
210 PRINT
220 PRINT"MOVE OR SHOOT(M/S)"TAB(0)
230 INPUT Q$
240 IF Q$="M"THEN 270
250 IF Q$="S"THEN 950
260 GOTO 210
270 PRINT"WHICH WAY(F/B/R/L)"TAB(0)
280 INPUT Q$
290 IF Q$="F"THEN 340
300 IF Q$="B"THEN 370
310 IF Q$="L"THEN 400
320 IF Q$="R"THEN 430
330 GOTO 210
340 LET X5=X
350 LET Y5=Y-1
360 GOTO 460
370 LET X5=X
380 LET Y5=Y+1
390 GOTO 460
400 LET X5=X-1
410 LET Y5=Y
420 GOTO 460
430 LET X5=X+1
440 LET Y5=Y
450 GOTO 460
460 IF X5<1  THEN 510
470 IF X5>15 THEN 510
480 IF Y5<1  THEN 510
490 IF Y5>15 THEN 510
500 GOTO 540
510 PRINT"THAT MOVE TAKES YOU OUT OF THE MAZE."
520 PRINT"MOVE NOT ALLOWED."
530 GOTO 1430
540 ON (A(X5,Y5)+1)GOTO 550,620,630,660,760,800,920
550 REM *** EMPTY SPACE
560 LET A(X,Y)=0
570 LET A(X5,Y5)=1
580 LET X=X5
590 LET Y=Y5
600 PRINT"MOVE ALLOWED."
610 GOTO 1430
620 REM *** IMPOSSIBLE TO GET HERE
630 REM *** BLOCED SPACE ROUTINE
640 PRINT"THAT SPACE IS BLOCKED."
650 GOTO 1430
660 REM *** RELOCATION ROUTINE
670 PRINT"YOU'VE BEEN R E L O C A T E D !!!"
680 GOSUB 2710
690 IF A(Z,W)>2 THEN 540
700 IF A(Z,W)<>0 THEN 680
710 LET A(Z,W)=1
720 LET A(X,Y)=0
730 LET X=Z
740 LET Y=W
750 GOTO 1430
```

```
760 REM *** CHANGE ALL , SUPER TRAP
770 PRINT"  YOU HIT THE SUPER TRAP!! YOU GET A NEW MAZE."
780 GOSUB 1830
790 GOTO 1430
800 REM *** HE WON !!
810 PRINT
820 PRINT"I DON'T BELIEVE IT BUT YOU WON THE GAME!"
830 PRINT"YOU GOT THE OBJECTIVE BEFORE"
840 PRINT"  THE TWONKY GOT YOU!!"
850 PRINT
860 PRINT
870 PRINT"TRY AGAIN(Y/N)"TAB(0)
880 INPUT Q$
890 IF Q$="Y"THEN 150
900 IF Q$="N"THEN 2750
910 GOTO 870
920 REM *** HE LANDED ON TWONKY !!
930 PRINT"YOU STEPPED ON THE TWONKY!"
940 GOTO1790
950 REM *** SHOOT ROUTINE
960 PRINT"WHICH WAY(F/B/R/L)"TAB(0)
970 INPUT Q$
980 IF Q$="F"THEN 1030
990 IF Q$="B"THEN 1060
1000 IF Q$="L"THEN 1090
1010 IF Q$="R"THEN 1120
1020 GOTO 210
1030 LET S1=0
1040 LET S2=-1
1050 GOTO 1140
1060 LET S1=0
1070 LET S2=1
1080 GOTO 1140
1090 LET S1=-1
1100 LET S2=0
1110 GOTO 1140
1120 LET S1=1
1130 LET S2=0
1140 LET R1=X
1150 LET R2=Y
1160 LET R1=R1+S1
1170 LET R2=R2+S2
1180 PRINT"Z A P--"TAB(0)
1190 IF R1<1 THEN 1240
1200 IF R1>15 THEN 1240
1210 IF R2<1 THEN 1240
1220 IF R2>15 THEN 1240
1230 GOTO 1280
1240 PRINT" FIZZLE..."
1250 PRINT"SHOT LEFT MAZE."
1260 PRINT"SHOT MISSED."
1270 GOTO1430
1280 IF A(R1,R2)<>2 THEN 1330
1290 PRINT" BLAST!!!!"
1300 PRINT"YOU HIT WALL."
1310 PRINT"SHOT MISSED."
1320 GOTO1430
1330 IF A(R1,R2)<>6 THEN 1160
1340 PRINT" OUCH!!"
1350 PRINT"TWONKY RETREATS."
1360 LET A(R1,R2)=R9
1370 GOSUB 2710
1380 IF A(Z,W)<>0 THEN 1370
1390 LET A(Z,W)=6
1400 LET R9=0
1410 LET X1=Z
1420 LET Y1=W
1430 GOSUB 1450
1440 GOTO 1570
1450 REM *** PRINT TWONKY AND OBJECTIVE DIST.
1460 PRINT
1470 PRINT"THE TWONKY IS"TAB(0)
1480 LET D=(SQR(ABS((X1-X)^2+(Y1-Y)^2)))
1490 PRINT D;TAB(0)
1500 PRINT" UNITS AWAY."
1510 PRINT"THE OBJECTIVE IS"TAB(0)
1520 LET D1=(SQR(ABS(X2-X)^2+(Y2-Y)^2))
1530 PRINT D1;TAB(0)
1540 PRINT"UNITS AWAY."
1550 PRINT
1560 RETURN
1570 REM *** TWONKYS LOGIC
1580 IF D<2 THEN 1790
1590 LET Z2=Y1
1600 LET Z1=X1
1610 IF X<X1 THEN 1680
1620 IF X>X1 THEN 1700
1630 IF Y<Y1 THEN 1660
1640 LET Z2=Y1+1
1650 GOTO 1710
1660 LET Z2=Y1-1
1670 GOTO 1710
1680 LET Z1=X1-1
1690 GOTO 1710
1700 LET Z1=X1+1
1710 LET A(X1,Y1)=R9
1720 LET R9=A(Z1,Z2)
1730 LET A(Z1,Z2)=6
1740 LET X1=Z1
1750 LET Y1=Z2
1760 PRINT"TWONKY MOVES...."
1770 GOSUB 1450
1780 IF D>=2 THEN 210
1790 PRINT
1800 PRINT"> > > S C H L O O R P !!! < < <"
1810 PRINT"THE TWONKY JUST ABSORBED YOU !! YOU LOSE."
1820 GOTO850
1830 REM *** SET UP NEW MAZE ROUTINE
1840 REM *** 1=PLAYER , 2=BLOCKED SPACES
1850 REM *** 3=RELOCATIONS , 4=SUPER TRAP
1860 REM *** 5=OBJEXTIVE , 6=TWONKY
1870 REM *** 0=EMPTY SPACES
1880 REM *** CLEAR MAZE
1890 MAT A=ZER
1900 REM *** PLACE THE BLOCKED SQUARES
1910 FOR I=1 TO 30
1920 GOSUB 2710
1930 IF A(Z,W)<>0 THEN 1920
1940 LET A(Z,W)=2
1950 NEXTI
1960 REM *** PLACE THE RELOCATIONS
1970 FOR I=1 TO 22
1980 GOSUB 2710
1990 IF A(Z,W)<>0 THEN 1980
2000 LET A(Z,W)=3
2010 NEXTI
2020 REM *** PLACE THE SPECIAL TRAP
2030 GOSUB 2710
2040 IF A(Z,W)<>0 THEN 2030
2050 LET A(Z,W)=4
2060 REM *** PLACE THE PLAYER
2070 GOSUB 2710
2080 IF A(Z,W)<>0 THEN 2070
2090 LET A(Z,W)=1
2100 LET X=Z
2110 LET Y=W
2120 REM *** PLACE THE OBJECTIVE
2130 GOSUB 2710
2140 IF A(Z,W)<>0 THEN 2130
2150 LET A(Z,W)=5
2160 LET X2=Z
2170 LET Y2=W
2180 REM *** PLACE THE TWONKY
2190 GOSUB 2710
2200 IF A(Z,W)<>0 THEN 2190
2210 LET A(Z,W)=6
2220 LET X1=Z
2230 LET Y1=W
2240 RETURN
2250 PRINT
2260 PRINT
2270 PRINT
2280 PRINTTAB(25);"TWONKY"
2290 PRINT
2300 PRINT
2310 PRINT"DO YOU WANT INSTRUCTIONS(Y/N)"TAB(0)
2320 INPUT Q$
2330 IF Q$="N"THEN 2700
2340 IF Q$<>"Y"THEN 2310
2350 PRINT
2360 PRINT
2370 PRINT
2380 PRINT"THIS IS THE GAME OF TWONKY.SOME HAVE SAID THAT IT IS"
2390 PRINT"A STROKE OF GENIUS...MOSTLY IT'S INVENTOR."
2400 PRINT
2410 PRINT"  YOU HAVE LANDED ON THE PLANET OF TWINKY AND"
2420 PRINT"ITS KING (KONG:THEIR KING IS KING KONG) HAS"
2430 PRINT"CAPTURED YOU. HE HAS PUT YOU IN A MAZE THAT IS"
2440 PRINT"15 * 15 UNITS LONG. YOU ARE IN THE DARK AND CANNOT"
2450 PRINT"SEE... YOU MUST GET TO THE OBJECTIVE SQUARE AND"
2460 PRINT"BE SET FREE."
2470 PRINT
2480 PRINT"    HAZARDS INCLUDE:"
2490 PRINT"SQUARES THAT YOU CANNOT GO INTO (30)."
2500 PRINT"SQUARES THAT RANDOMLY THROW YOU AROUND THE MAZE(22)"
2510 PRINT"SQUARE THAT SETS UP NEW MAZE AND ALL THAT'S IN IT(1)"
2520 PRINT"MONSTER CALLED TWONKY THAT CHASES YOU AND WILL"
2530 PRINT"    ABSORB YOU IF THE DISTANCE IT IS FROM YOU FALLS"
2540 PRINT"    BELOW 2 UNITS."
2550 PRINT"    THE TWONKY IS ALSO IMMUNE TO ALL TRAPS INCLUDING"
2560 PRINT"      WALLS."
2570 PRINT
2580 PRINT"    YOU CAN:"
2590 PRINT"MOVE ONE SQUARE  AT A TIME TO FIND OBJECTIVE"
2600 PRINT"    OR ESCAPE FROM THE TWONKY."
2610 PRINT"SHOOT AT THE TWONKY ONE DIRECTION AT A TIME."
2620 PRINT"  IF THE TWONKY IS HIT HE WILL BE REPLACED IN THE"
2630 PRINT"     MAZE RANDOMLY."
2640 PRINT
2650 PRINT"IF THE TWONKY ABSORBS YOU...YOU LOSE."
2660 PRINT" IF YOU LAND ON THE OBJECTIVE YOU WIN."
2670 PRINT
2680 PRINT"GOOD LUCK!"
2690 PRINT
2700 RETURN
2710 REM *** SUBROUTINE TO GET 2 RANDOM NUMBERS
2720 LET Z=(INT(RND(3)*15)+1)
2730 LET W=(INT(RND(3)*15)+1)
2740 RETURN
2750 END
```

```
THE TWONKY IS 7    UNITS AWAY.
THE OBJECTIVE IS 7.21110  UNITS AWAY.


MOVE OR SHOOT(M/S)?M
WHICH WAY(F/B/R/L)?F
MOVE ALLOWED.

THE TWONKY IS 7.07107    UNITS AWAY.
THE OBJECTIVE IS 6.70820  UNITS AWAY.

TWONKY MOVES....

THE TWONKY IS 6.08276    UNITS AWAY.
THE OBJECTIVE IS 6.70820  UNITS AWAY.


MOVE OR SHOOT(M/S)?M
WHICH WAY(F/B/R/L)?F
MOVE ALLOWED.

THE TWONKY IS 6.32456    UNITS AWAY.
THE OBJECTIVE IS 6.32456  UNITS AWAY.

TWONKY MOVES....

THE TWONKY IS 5.38516    UNITS AWAY.
THE OBJECTIVE IS 6.32456  UNITS AWAY.


MOVE OR SHOOT(M/S)?M
WHICH WAY(F/B/R/L)?R
THAT SPACE IS BLOCKED.

THE TWONKY IS 5.38516    UNITS AWAY.
THE OBJECTIVE IS 6.32456  UNITS AWAY.

TWONKY MOVES....

THE TWONKY IS 4.47214    UNITS AWAY.
THE OBJECTIVE IS 6.32456  UNITS AWAY.


MOVE OR SHOOT(M/S)?M
WHICH WAY(F/B/R/L)?L
THAT SPACE IS BLOCKED.

THE TWONKY IS 4.47214    UNITS AWAY.
THE OBJECTIVE IS 6.32456  UNITS AWAY.

TWONKY MOVES....

THE TWONKY IS 3.60555    UNITS AWAY.
THE OBJECTIVE IS 6.32456  UNITS AWAY.


MOVE OR SHOOT(M/S)?M
WHICH WAY(F/B/R/L)?F
MOVE ALLOWED.

THE TWONKY IS 4.24264    UNITS AWAY.
THE OBJECTIVE IS 6.08276  UNITS AWAY.

TWONKY MOVES....

THE TWONKY IS 3.60555    UNITS AWAY.
THE OBJECTIVE IS 6.08276  UNITS AWAY.


MOVE OR SHOOT(M/S)?M
WHICH WAY(F/B/R/L)?F
YOU'VE BEEN R E L O C A T E D !!!

THE TWONKY IS 3.16228    UNITS AWAY.
THE OBJECTIVE IS 8.60233  UNITS AWAY.

TWONKY MOVES....

THE TWONKY IS 3    UNITS AWAY.
THE OBJECTIVE IS 8.60233  UNITS AWAY.


MOVE OR SHOOT(M/S)?M
WHICH WAY(F/B/R/L)?F
MOVE ALLOWED.

THE TWONKY IS 2    UNITS AWAY.
THE OBJECTIVE IS 7.81025  UNITS AWAY.

TWONKY MOVES....

THE TWONKY IS 1    UNITS AWAY.
THE OBJECTIVE IS 7.81025  UNITS AWAY.


> > > S C H L O O R P !!! < < <
THE TWONKY JUST ABSORBED YOU !! YOU LOSE.
```

← At this point we don't really have much information. Let's say we're at O. Twonky could be at any of 4 • locations and objective at 8 □ locations.

← Forward move to 1; Twonky must be a or b $\left[\sqrt{1^2+7^2}\right]$. Objective must be c or d $\left[\sqrt{6^2+3^2}\right]$

← Twonky must have moved to a' or b' $\left[\sqrt{6^2+1^2}\right]$

← We move to 2; Still don't know if objective is c or d or if Twonky is a' or b'.

← Twonky moves to a" or b" $\left[\sqrt{5^2+2^2}\right]$; can't tell which.

← Tried to move right. Blocked !!

← Twonky closes in by moving to a''' or b'''.

← Aarrrgg! Left is blocked too!

← Twonky moves to a^4 or b^4.

← Finally got a move in (to 3).

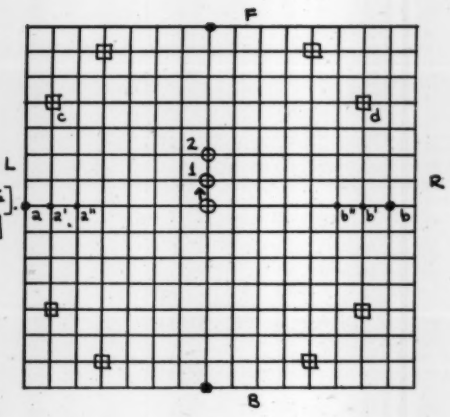
← Twonky moves to a^5 or b^5.

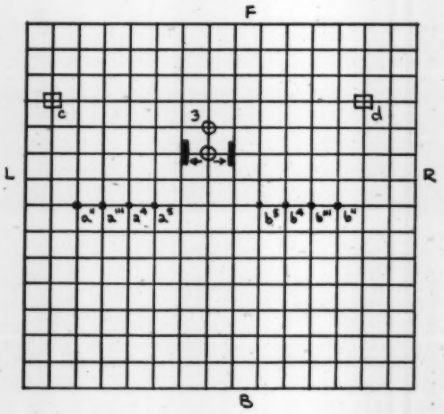
← This just isn't our day! Now we're 3+1 from Twonky and 7+5 from Objective. If it's Objective c and Twonky a, we've got to be at 4 or 5; otherwise we're at 4' or 5'.

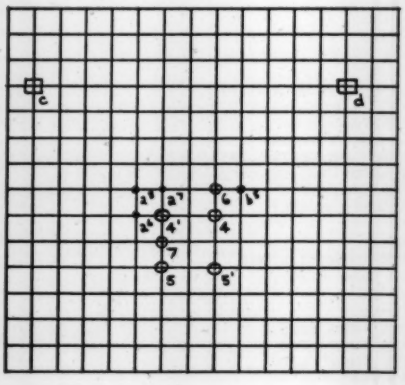
← Bad news. Twonky moves to either a^6 or a^7; ditto for b moves.

← Move to either 6 or 7; except Objective is 6+6 away, hence we're at 7 and Twonky is at a?

← HELLLOPP !!







SWARMS

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Language: BASIC (DEC 10)
Description: SWARMS is a computer simulation (fancy word for game) that was conceived from the book *The Swarm* by Arthur Herzog. The program puts you in charge of the defense of the entire United States when swarms of ferocious South American hybrid bees suddenly start appearing in different sections of the country. The program is provided with in depth instructions which explain the situation very thoroughly.

My goals for this game were to create a program that was 1) my own creation, not an improvement in somebody else's game, 2) as realistic as possible, 3) not another Star Trek game. Since I wanted this project to be a test of my programming skills, I wrote the instructions first and made the game to follow the instruction as closely as possible. The instructions were updated at the end but the program ended up pretty much what I had planned.

I would like to give special credit to the Albuquerque Public School System who own and operate a DEC-10 computer system just for high school students. Their set up is slightly ahead of the times.

I would also like to give no credit to the Honolulu Public School System which owns and operates nothing for high school students. Their entire city is years behind the times.

NOTE: When adapting this program for other computer systems, special attention should be paid to the "tab" and "print using" statements (5100-5250) and the margin statement (90) which is not necessarily needed.

Rand Miller at home with a Friend.

```
DO YOU NEED INSTRUCTIONS ?NO
TIME:    1
ENTER YOUR LAST NAME FOR IDENTIFICATION CHECK.
 ?MILLER
ENTER YOUR CODE WORD FOR LATER VARIFICATION.
 ?SWARMS

COMMAND ?1
TIME:    2
1)       ATTACK SCAN MAP

------------------------------------------------------------

                CANADA: NO INFORMATION
               ------------------------
               1   1   1   1     1     1\_
               1   1   1   1 *   1     1  \__/---/
               1   1___1___1___1___1___1    /
               1___1   1   1     1     1   1   1
               1   1   1   1     1     1___1___1
               1   1___1___1___1___1___1   1   1
                \  1   1   1     1     1   1   1
                 \ 1   1   1     1     1   1___/
                  \1___1___1___1___1___1___1 *1
                            \_    1           \ 1
                              \   1           1 1
                               \_1            1_1
                      MEXICO: NO INFORMATION

------------------------------------------------------------


COMMAND ?2
TIME:    3
2)       ETA REPORT

SECTION ?9
*****************************************
THE BEES WILL ARRIVE AT THE MAJOR CITY IN
         SECTION 9 AT 9 HOURS.
*****************************************

COMMAND ?2
TIME:    4
2)       ETA REPORT

SECTION ?21
*****************************************
THE BEES WILL ARRIVE AT THE MAJOR CITY IN
         SECTION 21 AT 10 HOURS.
*****************************************
*THE SWARM IN SECTION 9 HAS SPREAD TO SECTION 8

COMMAND ?3
TIME:    5

3)       BATTLE PHASE OPTIONS
SECTION ?8
PHASE ?3
PROJECT BRUSH FIRE: PHASE THREE, NOW BEING ATTEMPTED.
*THE PHASE ON SECTION 8 WAS SUCCESSFUL
*THE SWARM IN SECTION 8 IS READY TO BE DESTROYED
*THE SWARM IN SECTION 9 HAS SPREAD TO SECTION 10
*THE SWARM IN SECTION 21 HAS SPREAD TO SECTION 20

COMMAND ?3
TIME:    6

3)       BATTLE PHASE OPTIONS
SECTION ?20
PHASE ?3
PROJECT BRUSH FIRE: PHASE THREE, NOW BEING ATTEMPTED.

COMMAND ?3
TIME:    7

3)       BATTLE PHASE OPTIONS
SECTION ?10
PHASE ?3
PROJECT BRUSH FIRE: PHASE THREE, NOW BEING ATTEMPTED.
*THE PHASE ON SECTION 10 WAS SUCCESSFUL

COMMAND ?3
TIME:    8
```

```
00010 PRINT"DO YOU NEED INSTRUCTIONS";
00020 INPUT I$
00030 PRINT"TIME:  1"
00040 PRINT"ENTER YOUR LAST NAME FOR IDENTIFICATION CHECK,"
00050 INPUT N$
00060 PRINT"ENTER YOUR CODE WORD FOR LATER VARIFICATION,"
00070 INPUT C$
00080 IF I$<>"YES" THEN 3370
00090 MARGIN 100
00100 PRINT
00110 PRINT
00120 PRINT
00130 PRINT"          IN 1956, AFICULTURIST  WARWIC  KERR BROUGHT TWENTY AFRICAN"
00140 PRINT"QUEEN BEES INTO BRAZIL.    THOUGH IT IS KNOWN TO BE FEROCIOUS,  THE"
00150 PRINT"AFRICAN BEE PRODUCES 30  PERCENT MORE MONEY THAN EITHER THE ITALIAN"
00160 PRINT"OR GERMAN BEE THAT LONG DOMINATED BRAZILIAN BEEKEEPING.  KERR PLAN-"
00170 PRINT"NED TO CROSS-BREED HIS AFRICANS TO PRODUCE A MORE GENTLE BEE.  WHAT"
00180 PRINT"HE OBTAINED, HOWEVER, WAS A BEE WITH A DISPOSITION SO NASTY THAT IT"
00190 PRINT"THREATENED THE LIVES  AND LIVELIHOOD  OF ALMOST EVERY  BEEKEEPER IN"
00200 PRINT"8 STATES OF BRAZIL.  IN JUNE 1968, THE AGRARIAN DEFENSE DERECTORATE"
00210 PRINT"IN LIMA, PERU, BEGAN EMERGENCY  MEASURES TO PREVENT AN INVASION OF"
00220 PRINT"THE DEADLY AFRICAN BEES FROM BRAZIL.  THE BEES QUICKLY SPREAD OVER"
00230 PRINT"AN AREA ABOUT  EQUAL TO THE SIZE OF THE CONTINENTAL  UNITED STATES."
00240 PRINT"SWARMS OF THESE FEROCIOUS AFRICAN MONEY BEES ARE NOW  MOVING TOWARD"
00250 PRINT"THE UNITED STATES AT THE RATE OF ABOUT 200 MILES A YEAR,  AND THERE"
00260 PRINT"SEEMS TO BE NO NATURAL  BARRIER TO BLOCK THEM, ACCORDING TO A STUDY"
00270 PRINT"FINANCED BY THE DEPARTMENT OF AGRICULTURE.  THIS GAME IS A SIMULA-"
00280 PRINT"TION OF  WHAT MIGHT HAPPEN  WHEN AND IF THE  BEES REACH THE  UNITED"
00290 PRINT"STATES.  IN THIS GAME ONE PERSON IS IN CHARGE OF THE DEFENSE OF THE"
00300 PRINT"ENTIRE UNITED STATES.  THAT ONE PERSON, THROUGH THE USE OF A COMPU-"
00310 PRINT"TER, HAS TO KEEP TRACK OF THE BEES AND TRY TO COMBAT THEM.  COMPU-"
00320 PRINT"TER RADAR  SUBSTATIONS ARE  POSITIONED IN 21 STRATEGIC AREAS OF THE"
00330 PRINT"UNITED  STATES TO SHOW ANY  SWARMS IN THOSE AREAS.  THE SWARMS CAN"
00340 PRINT"AND  WILL GROW AND SPREAD IF THEY ARE NOT COMBATTED.  THEY ARE ALSO"
00350 PRINT"CONSTANTLY  MOVING TOWARD MAJOR CITIES.  EACH SECTION HAS ONE CITY"
00360 PRINT"THAT IS CONSIDERED  MAJOR.  THE SIZE OF THE  SWARMS ARE SHOWN ON A"
00370 PRINT"MAP AND THE ESTIMATED TIME OF ARRIVAL (ETA) OF THE BEES TO A MAJOR"
00380 PRINT"CITY IS  PRINTED OUT IN CHART FORM.  THE OBJECT OF THIS GAME IS TO"
00390 PRINT"DESTROY ALL OF THE SWARMS WITH AS FEW CASUALTIES AS POSSIBLE.  ALL"
00400 PRINT"OF THE COMPUTER  COMMANDS THAT CAN BE USED WILL NOW BE PRINTED OUT"
00410 PRINT"ALONG WITH A DETAILED EXPLANATION OF EACH ONE.  IF YOU WANT SHORT"
00420 PRINT"INSTRUCTIONS THE NEXT TIME YOU PLAY ENTER 'SHORT' WHEN ASKED IF YOU"
00430 PRINT"WANT INSTRUCTIONS."
00440 PRINT
00450 PRINT
00460 PRINT
00470 PRINT
00480 PRINT
00490 PRINT
00500 PRINT
00510 PRINT
00520 PRINT"                              COMMANDS"
00530 PRINT"*****************************************************************"
00540 PRINT
00550 PRINT"COMMAND 1:    ATTACK SCAN MAP"
00560 PRINT
00570 PRINT"          THIS COMMAND PRINTS OUT THE MAP OF THE U.S. AND THE"
00580 PRINT"          BEE ATTACKS.  HERE IS HOW THE SECTIONS ARE LAID OUT."
00590 PRINT
00600 PRINT
00610 PRINT
00620 PRINT
00630 PRINT
00640 PRINT                                  CANADA: NO INFORMATION"
00650 PRINT                                                          "
00660 PRINT                                                          "
00670 PRINT                                                          "
00680 PRINT                                                          "
00690 PRINT                                                          "
00700 PRINT                                                          "
00710 PRINT                                                          "
00720 PRINT                                                          "
00730 PRINT                                                          "
00740 PRINT                                                          "
00750 PRINT                                                          "
00760 PRINT                                                          "
00770 PRINT                                                          "
00780 PRINT                                                          "
00790 PRINT                                                          "
00800 PRINT                                                          "
00810 PRINT
00820 PRINT
00830 PRINT
00840 PRINT
00850 PRINT
00860 PRINT
00870 PRINT
00880 PRINT
00890 PRINT
00900 PRINT
00910 PRINT
00920 PRINT
00930 PRINT
00940 PRINT
00950 PRINT
00960 PRINT
00970 PRINT
00980 PRINT
00990 PRINT
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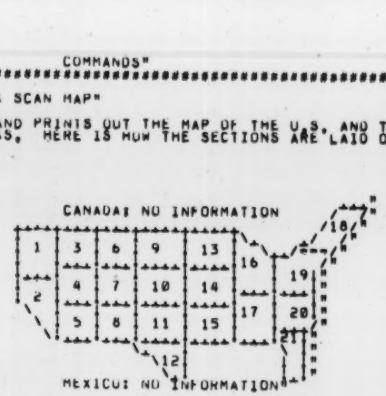


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                                  MEXICO: NO INFORMATION"
                                                          "
                                                          "
                                                          "
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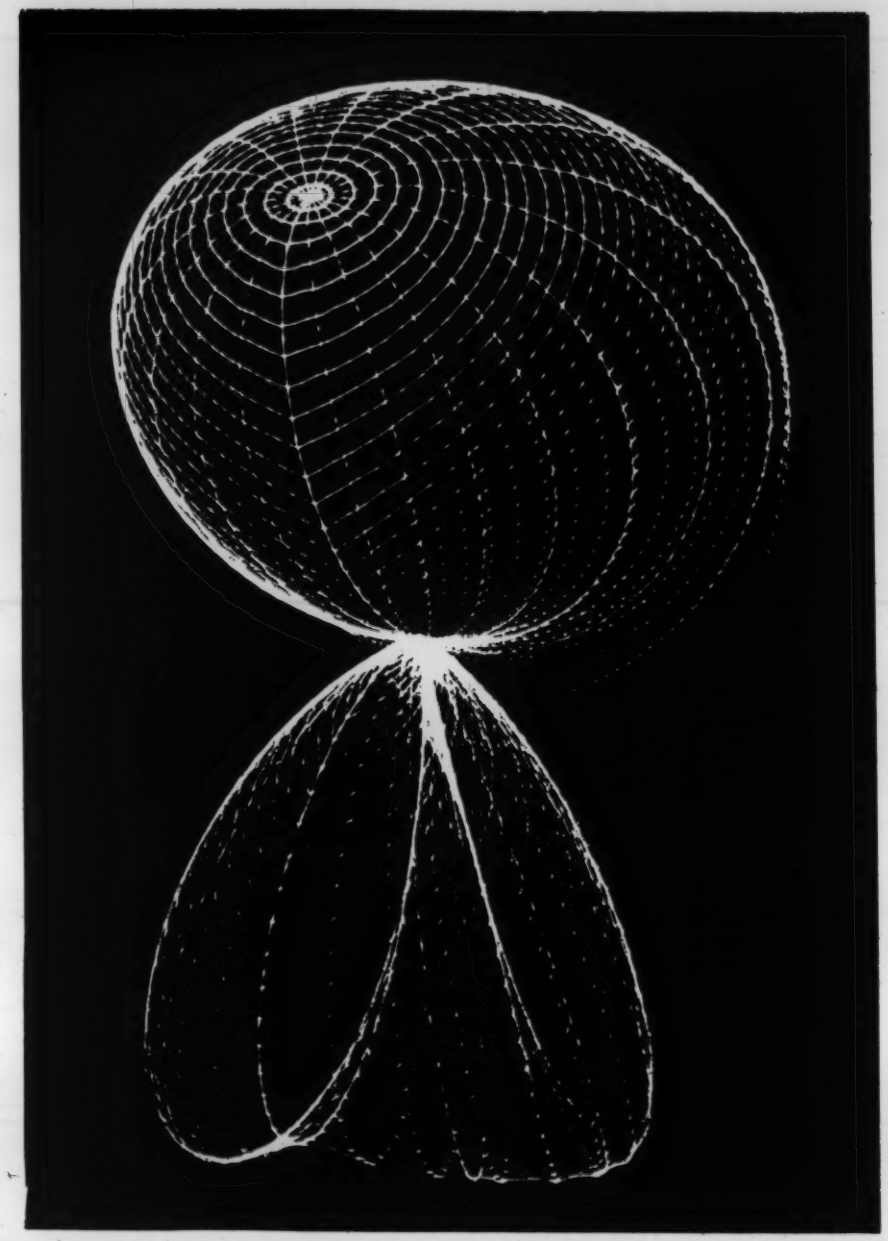
```
02980 PRINT"          IF THE POPULATION IS EVACUATED ONLY THE BEES ARE DES-"
02990 PRINT"          TROYED AND THE POPULATION WILL RETURN TO THE CITY AFTER"
03000 PRINT"          ABOUT 7 COMPUTER HOURS.  IF THE POPULATION IS NOT EVAC-"
03010 PRINT"          UATED IT IS DESTROYED WITH THE BEES AND THE ENTIRE SEC-"
03020 PRINT"          TION BECOMES UNINHABITED.  THE BEES WILL NOT ENTER IN-"
03030 PRINT"          TO A SECTION THAT IS COMPLETELY UNINHABITED, SO THAT"
03040 PRINT"          SECTION WILL BE ENTIRELY EMPTY FOR THE REMAINDER OF THE"
03050 PRINT"          GAME"
03060 PRINT
03070 PRINT"###########################################################################"
03080 PRINT
03090 PRINT"COMMAND 6:        CASUALTY REPORT"
03100 PRINT
03110 PRINT"          THIS COMMAND PERMITS YOU TO FIND OUT HOW MANY BEE"
03120 PRINT"          RELATED CASUALTIES THERE ARE IN THE SECTIONS.  TO"
03130 PRINT"          USE THIS COMMAND FOR ALL THE SECTIONS ENTER ZERO(0)"
03140 PRINT"          FOR THE SECTION NUMBER.  A CASUALTY REPORT IS AUTO-"
03150 PRINT"          MATICALLY ISSUED AT THE END OF A GAME UNLESS THE"
03160 PRINT"          GAME CANCEL COMMAND IS USED."
03170 PRINT
03180 PRINT"###########################################################################"
03190 PRINT
03200 PRINT"COMMAND 7:        COMMAND(SHORT)"
03210 PRINT
03220 PRINT"          THIS COMMAND PRINTS OUT ALL OF THE COMMANDS IN A"
03230 PRINT"          SHORT VERSION WITH NO EXPLANATIONS."
03240 PRINT
03250 PRINT"###########################################################################"
03260 PRINT
03270 PRINT"COMMAND 8:        CANCEL GAME"
03280 PRINT
03290 PRINT"          THIS COMMAND CANCELS THE GAME YOU ARE PLAYING AND"
03300 PRINT"          THEN ASK YOU IF YOU WANT TO PLAY ANOTHER ONE."
03310 PRINT
03320 PRINT"###########################################################################"
03330 PRINT
03340 PRINT
03350 PRINT
03360 PRINT
03370 REM     *** CREATE 2 INITIAL SWARMS ***
03380 RANDOMIZE
03390 DIM E(25),S(25),A3(25),U(25),G(25),M(25),D(25),C(25),V(25),K(25),R(25)
03400 A1=INT(RND*21+1)
03410 A2=INT(RND*21+1)
03420 IF A1=A2 GOTO 3410
03430 S(A1)=INT(RND*5+2)
03440 S(A2)=INT(RND*5+2)
03450 E(A1)=INT(RND*9+6)
03460 E(A2)=INT(RND*9+6)
03470 IF I$="SHORT" THEN 8160
03480 REM     *** SUBTRACT ONE HOUR FROM ALL ETA'S ***
03490 I$="NO"
03500 FOR A=1 TO 21
03510 IF E(A)=0 THEN 3530
03520 GOTO 3540
03530 IF U(A)=0 THEN 3750
03540 IF S(A)=1 THEN 3750
03550 IF ABS(U(A))=1 THEN 3660
03560 IF ABS(E(A))=1 THEN 3600
03570 E(A)=E(A)-1
03580 C(A)=C(A)+(17-E(A))
03590 GOTO 3750
03600 IF E(A)=-1 THEN 3640
03610 PRINT"*THE BEES HAVE ARRIVED IN THE MAJOR CITY IN SECTION"A
03620 E(A)=-1
03630 U(A)=6
03640 U(A)=U(A)-1
03650 GOTO 3750
03660 IF U(A)=1 THEN 3750
03670 PRINT"*THE BEES HAVE DESTROYED THE MAJOR CITY IN SECTION"A
03680 U(A)=-1
03690 IF V(A)<>-1 THEN 3720
03700 PRINT"BUT THE POPULATION HAS BEEN EVACUATED"
03710 GOTO 3740
03720 K(A)=1
03730 C(A)=(1000000*(RND*A+1))+C(A)
03740 GOTO 3750
03750 NEXT A
03760 REM     *** ADD ONE UNIT TO TIME ***
03770 T=T+1
03780 REM     *** CREATE NEW SWARM ***
03790 IF T/30<>INT(T/30) THEN 3880
03800 A=INT(RND*21+1)
03810 IF S(A)<>0 THEN 3790
03820 IF M(A)<>0 THEN 3790
03830 IF K(A)<>0 THEN 3790
03840 S(A)=INT(RND*5+2)
03850 E(A)=INT(RND*9+16)
03860 C(A)=INT(RND*10)
03870 PRINT"A NEW SWARM IS REPORTED IN SECTION"A
03880 REM     *** CHECK CUMBATED SWARMS ***
03890 FOR A=1 TO 21
03900 IF T<>S(A) THEN 4000
03910 IF S(A)<>1 THEN 4000
03920 S(A)=0
03930 G(A)=0
03940 E(A)=0
03950 M(A)=0
03960 K(A)=0
```

```
01990 PRINT"*PHASE THREE!"
02000 PRINT"          PROJECT BRUSH FIRE-                              1 HOUR"
02010 PRINT"-------------------------------------------------------------------------"
02020 PRINT"          LINE-BEARING WORKERS"
02030 PRINT"          STIMULATE AGGRESSION"
02040 PRINT
02050 PRINT"     HUNDREDS OF MILLIONS OF ARTIFICIALLY-REARED WORKERS (KEYED"
02060 PRINT"WITH AN ATTACK PHEROMONE) ARE DROPPED ON INFESTED AREAS.  THEY"
02070 PRINT"CHEMICALLY COMPELLED TO SEARCH FOR AND ATTACK ANY AFRICAN BEEHIVE"
02080 PRINT"IN THE VICINITY CAUSING REDUCTION OF THE AFRICAN POPULATION."
02090 PRINT
02100 PRINT"+++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++"
02110 PRINT
02120 PRINT"*PHASE FOUR!"
02130 PRINT"          PROJECT STERILE MALE-                            4 HOURS"
02140 PRINT"-------------------------------------------------------------------------"
02150 PRINT"          LINE-BEARING DRONES"
02160 PRINT"          STERILIZATION"
02170 PRINT
02180 PRINT"     HUNDREDS OF MILLIONS OF ARTIFICIALLY-REARED DRONES WOULD BE"
02190 PRINT"STERILIZED AND DROPPED FROM THE AIR ON INFESTED AREAS.  MATING WITH"
02200 PRINT"THE AFRICAN QUEENS, THEY WOULD INSERT USELESS SPERM TO FILL UP THE"
02210 PRINT"QUEEN.  THE UNFERTILIZED QUEEN WOULD THEN ONLY PRODUCE DRONE EGGS."
02220 PRINT
02230 PRINT"+++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++"
02240 PRINT
02250 PRINT"*PHASE FIVE!"
02260 PRINT"          DESTRUCTION-                                     3 HOURS"
02270 PRINT"-------------------------------------------------------------------------"
02280 PRINT"          BEE WARDENS"
02290 PRINT
02300 PRINT"     THIS DEFENSE IS TO BE USED ONLY AFTER THE BEE POPULATION"
02310 PRINT"HAS BEEN REDUCED BY ONE OF THE LOWER NUMBER PHASES.  TRAINED BEE"
02320 PRINT"WARDENS WILL ENTER THE FOREST IN A LIMITED AREA AND FINISH OFF"
02330 PRINT"THE BEES THAT ARE LEFT."
02340 PRINT"+++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++"
02350 PRINT
02360 PRINT"*PHASE SIX!"
02370 PRINT"          URBAN DEFENSES-                                  1 HOUR EACH"
02380 PRINT"-------------------------------------------------------------------------"
02390 PRINT"          ISOLATION DEFENSES"
02400 PRINT"          FINAL RESORT"
02410 PRINT
02420 PRINT"     A) FLIGHT PATTERNS"
02430 PRINT"          COATED METAL FOIL STRIPS ARE DROPPED ON SWARM TO SET"
02440 PRINT"          UP VIBRATIONS IN THE AIR TO DISTURB BEES FLIGHT PAT-"
02450 PRINT"          TERNS."
02460 PRINT"     B) SONIC BOOM"
02470 PRINT"          F-111A'S FLY THROUGH SWARM OF BEES AT SONIC SPEEDS"
02480 PRINT"          TO COMBINE SONIC BOOM,JET EXHAUST,AND JET STREAM."
02490 PRINT"     C)SUPER-SONIC BEAMS"
02500 PRINT"          SUPER-SONIC BEAM SYNTHESIZER, ORIGINALLY MEANT TO CONFUSE"
02510 PRINT"          THE GUIDANCE SYSTEMS OF SAM MISSILES, ARE PLACED IN STRA-"
02520 PRINT"          TEGIC AREAS AROUND THE CITY.  THE BEES WON'T BE KILLED"
02530 PRINT"          BUT THEIR SOLAR AND GRAVITATIONAL ORIENTATION SHOULD BE"
02540 PRINT"          DISRUPTED ENOUGH TO CAUSE THEM TO FLY INTO BUILDINGS OR"
02550 PRINT"          DIVE INTO THE GROUND."
02560 PRINT"     D)POLLUTION"
02570 PRINT"          THOUSANDS OF CARS ARE POSITIONED ALONG MAJOR TRAFFIC"
02580 PRINT"          ARTERIES OF THE CITY.  THEY ARE WIRED TO BE STARTED BY"
02590 PRINT"          REMOTE CONTROL.  THE BEES SHOULD DIE FROM THE POLLUTION."
02600 PRINT"     E)METHYL PARATHION"
02610 PRINT"          SMALL CROP DUSTERS ARE SENT UP TO SPRAY A METHYL PARA-"
02620 PRINT"          THION BARRIER IN THE PATH OF THE BEES."
02630 PRINT"     F)FIRE WALL"
02640 PRINT"          KEROSENE FILLED TANKER TRUCKS ARE IGNITED IN THE PATH OF"
02650 PRINT"          THE BEES.  SOME BEES SHOULD BE BURNED AND OTHERS SHOULD"
02660 PRINT"          BE CARRIED UP BY THE HOT AIR TO ALTITUDES BEYOND THEIR"
02670 PRINT"          CAPABILITIES."
02680 PRINT"     G)STROBE LIGHT"
02690 PRINT"          A HIGH-INTENSITY STROBE LIGHT IS POSITIONED ON TOP OF A"
02700 PRINT"          HIGH BUILDING.  IT IS SURROUNDED BY A HIGH-VOLTAGE WIRE"
02710 PRINT"          MESH.  THE BEES SHOULD BE ATTRACTED TO THE STROBE AND"
02720 PRINT"          ELECTROCUTED."
02730 PRINT
02740 PRINT"###########################################################################"
02750 PRINT
02760 PRINT"COMMAND 4:        EVACUATION"
02770 PRINT
02780 PRINT"          THIS COMMAND IS USED TO EVACUATE A MAJOR CITY IN ANY"
02790 PRINT"          SECTION.  THE EVACUATION PROCESS TAKES ABOUT 5 COMPUTER"
02800 PRINT"          HOURS TO COMPLETE.  IT IS NEVER REQUIRED FOR YOU TO"
02810 PRINT"          EVACUATE A CITY FOR ANY REASON.  THE COMPUTER WILL NOT"
02820 PRINT"          ALLOW THE EVACUATION OF A MAJOR CITY IN A SECTION IN"
02830 PRINT"          WHICH NO SWARMS ARE REPORTED.  NO BATTLE PHASE OPTIONS"
02840 PRINT"          CAN BE USED IN A SECTION THAT IS BEING EVACUATED UNTIL"
02850 PRINT"          IT IS COMPLETELY EVACUATED."
02860 PRINT
02870 PRINT"###########################################################################"
02880 PRINT
02890 PRINT"COMMAND 5:        NUCLEAR DESTRUCTION"
02900 PRINT
02910 PRINT"          ANY CITY CAN BE DESTROYED COMPLETELY BY USING THIS COM-"
02920 PRINT"          MAND.  THE CITY DOES NOT NECESSARILY HAVE TO BE EVAC-"
02930 PRINT"          UATED TO EXECUTE THIS COMMAND.  IF THE BEES HAVE NOT"
02940 PRINT"          ENTERED THE MAJOR CITY THE COMPUTER WILL NOT ALLOW IT"
02950 PRINT"          TO BE DESTROYED USING THIS METHOD.  BEFORE USING THIS"
02960 PRINT"          COMMAND IT IS FIRST NECESSARY FOR YOU TO ENTER YOUR "
02970 PRINT"          NAME AND CODEWORD EXACTLY AS YOU DID AT THE BEGINNING."
```

```
04960 IF S(A)>4 THEN 5030
04970 IF S(A)>1 THEN 5030
04980 IF S(A)>0 THEN 5010
04990 LET A$(A)="
05000 GOTO 5080
05010 LET A$(A)="."
05020 GOTO 5080
05030 LET A$(A)="+"
05040 GOTO 5080
05050 LET A$(A)="*"
05060 GOTO 5080
05070 LET A$(A)="8"
05080 NEXT A
05090 PRINT"------------------------------------------------------------"
05100 PRINT:TAB(48)"  "
05110 PRINT:TAB(20)"CANADA: NO INFORMATION     /  /"
05120 PRINT USING 5200,A$(16)
05130 PRINT:TAB(15)"  |  |  |
```

```
05950   IF S(A)=0 THEN 5970
05960   GOTO 5990
05970   PRINT"NO SWARM IS REPORTED IN SECTION"A
05980   GOTO 3480
05990   IF S(A)<>1 THEN 6030
06000   IF P=3 THEN 6070
06010   PRINT"THE DESTRUCTION PHASE SHOULD BE USED IN SECTION"A
06020   GOTO 3480
06030   IF E(A)<>-1 THEN 6070
06040   IF P=6 THEN 6070
06050   PRINT"URBAN DEFENSES SHOULD BE USED IN SECTION"A
06060   GOTO 3480
06070   N=RND
06080   ON P GOTO 6090,6180,6270,6330,6420,6480
06090   REM *PHASE 1*
06100   PRINT"BEE COCKTAIL: PHASE ONE, NOW BEING ATTEMPTED."
06110   IF N>.95 THEN 3480
06120   G(A)=T +INT(RND*3+1)
06130   IF S(A)>5 THEN 6160
06140   LET M(A)=S(A)-2
06150   GOTO 3480
06160   LET M(A)=S(A)-5
06170   GOTO 3480
06180   REM *PHASE 2*
06190   PRINT"PROJECT QUEEN: PHASE TWO, NOW BEING ATTEMPTED."
06200   IF N>.92 THEN 3480
06210   G(A)=T +INT(RND *3+4)
06220   IFS(A)>3 THEN 6250
06230   M(A)=1
06240   GOTO 3480
06250   M(A)=S(A)-1
06260   GOTO 3480
06270   REM *PHASE 3*
06280   PRINT"PROJECT BRUSH FIRE: PHASE THREE, NOW BEING ATTEMPTED."
06290   IF N>.96 THEN 3480
06300   G(A)=T+1
06310   M(A)=2
06320   GOTO 3480
06330   REM *PHASE 4*
06340   PRINT"PROJECT STEHILE MALE: PHASE FOUR, NOW BEING ATTEMPTED."
06350   IF N>.89 THEN 3480
06360   G(A)=T+INT(RND*3+3)
06370   IF S(A)>6 THEN 6400
06380   M(A)=S(A)-1
06390   GOTO 3480
06400   M(A)=4
06410   GOTO 3480
06420   REM *PHASE 5*
06430   IF S(A)<>1 THEN 6610
06440   PRINT"DESTRUCTION: PHASE FIVE, NOW BEING ATTEMPTED."
06450   IF N>.7 THEN 3480
06460   G(A)=T+INT(RND * 3+2)
06470   GOTO 3480
06480   REM *PHASE 6*
06490   IF E(A)<>-1 THEN 6010
06500   PRINT"URBAN DEFENSE";
06510   INPUT D$
06520   C(A)=C(A)+INT(200*RND)
06530   IF RND >.6 THEN 3480
06540   IF D$="A" THEN 6630
06550   IF D$="B" THEN 6690
06560   IF D$="C" THEN 6750
06570   IF D$="D" THEN 6810
06580   IF D$="E" THEN 6870
06590   IF D$="F" THEN 6910
06600   IF D$="G" THEN 6950
06610   PRINT"INVALID URBAN DEFENSE: PLEASE START AGAIN."
06620   GOTO 3480
06630   REM *A*
06640   IF S(A)>5 THEN 6670
06650   S(A)=S(A)-1
06660   GOTO 6980
06670   S(A)=2
06680   GOTO 6980
06690   REM *B*
06700   IF S(A)>4 THEN 6730
06710   S(A)=S(A)-3
06720   GOTO 6980
06730   S(A)=S(A)-2
06740   GOTO 6980
06750   REM *C*
06760   IF S(A)>7 THEN 6790
06770   S(A)=S(A)-3
06780   GOTO 6980
06790   S(A)=1
06800   GOTO 6980
06810   REM *D*
06820   IF S(A)>3 THEN 6850
06830   S(A)=1
06840   GOTO 6980
06850   S(A)=S(A)-3
06860   GOTO 6980
06870   REM *E*
06880   IF RND>.5 THEN 6980
06890   S(A)=2
06900   GOTO 6980
06910   REM *F*
06920   IF RND >.4 THEN 6980
06930   S(A)=1
06940   GOTO 6980
06950   REM *G*
06960   IF RND>.8 THEN 6980
06970   S(A)=S(A)-4
06980   PRINT"THE URBAN DEFENSE IN SECTION"A"WAS SUCESSFUL"
06990   IF S(A)>1 THEN 3480
07000   S(A)=1
07010   U(A)=1
07020   PRINT"*SWARM IN SECTION"A"IS READY TO BE DESTROYED"
07030   GOTO 3480
07040   REM    *** EVACUATION PROCEDURE ***
07050   PRINT
07060   PRINT"4)          EVACUATION PROCEDURE"
07070   PRINT"SECTION";
07080   INPUT A
07090   IF S(A)=0 THEN 7150
07100   IF V(A)>0 THEN 7170
07110   IF V(A)=-1 THEN 7190
07120   IF K(A)>0 THEN 7210
07130   IF U(A)=-1 THEN 7210
07140   GOTO 7230
07150   PRINT"COMPUTER FAILSAFE...NO SWARMS REPORTED IN SECTION"A
07160   GOTO 3480
07170   PRINT"SECTION"A"IS BEING EVACUATED ALREADY"
07180   GOTO 3480
07190   PRINT"CITY IN SECTION"A"IS ALREADY EVACUATED"
07200   GOTO 3480
07210   PRINT"POPULATION IN SECTION"A"HAS BEEN DESTROYED"
07220   GOTO 3480
07230   PRINT"EVACUATION PROCEDURE, NOW IN PROCCESS"
07240   V(A)=5+1
07250   GOTO 3480
07260   REM    *** NUCLEAR DESTRUCTION SEQUENCE ***
07270   PRINT
07280   PRINT"5)          NUCLEAR DESTRUCTION SEQUENCE"
07290   PRINT"PLEASE ENTER YOUR NAME"
07300   INPUT N1$
07310   IF N$<>N1$ THEN 7490
07320   PRINT"PLEASE ENTER YOUR CODEWORD"
07330   INPUT C1$
07340   IF C$<>C1$ THEN 7490
07350   PRINT"POSITIVE IDENTIFICATION CHECK "G"G"G"G"G"G"G"
07360   PRINT"CODEWORD CHECK IS VALID "G"
07370   PRINT"IU SEQUENCE COMPLETED"
07380   PRINT"PLEASE ENTER SECTION "
07390   INPUT A
07400   IF E(A)<>-1 THEN 7440
07410   IF S(A)=0 THEN 7470
07420   PRINT
07430   GOTO 7530
07440   PRINT"COMPUTER FAILSAFE: BEES HAVE NOT ARRIVED IN THE MAJOR "
07450   PRINT"CITY IN SECTION"A
07460   GOTO 3480
07470   PRINT"COMPUTER FAILSAFE: NO SWARM REPORTED IN SECTION"A
07480   GOTO 3480
07490   PRINT"IU SEQUENCE DEFAULT.....START AGAIN"
07500   GOTO 3480
07510   PRINT"NEUCLEAR DESTRUCTION ABORTED."
07520   GOTO 3480
07530   PRINT"BOMB IN SECTION"A"IS NOW ACTIVATED"
07540   IF K(A)=1 THEN 7600
07550   IF V(A)=-1 THEN 7600
07560   PRINT"SECTION"A"HAS NOT BEEN EVACUATED"
07570   PRINT"DO YOU WISH TO CONTINUE"
07580   INPUT K$
07590   IF K$<>"YES" THEN 7510
07600   PRINT"PUSH RETURN FOR INSTANTANIOUS DETONATION"
07610   INPUT F$
07620   PRINT"^BOMB ^HAS BEEN ^DETUNATED^G ^G"
07630   PRINT"SWARM IS DESTROYED^G ^G ^G"
07640   PRINT"CITY IS DESTROYED ^G ^G ^G"
07650   C(A)=C(A)+2413
07660   S(A)=0
07670   E(A)=0
07680   V(A)=0
07690   U(A)=0
07700   G(A)=0
07710   M(A)=0
07720   IF K(A)=1 THEN 7810
07730   IF V(A)<>-1 THEN 7800
07740   PRINT"THE POPULATION WILL MOVE BACK TO THE"
07750   PRINT"CITY IN SECTION"A"WHEN THE RADIATION"
07760   PRINT"LEVEL HAS DECREASED. "
07770   K(A)=2
07780   R(A)=T+7
07790   GOTO 3480
07800   C(A)=INT(2000000*(RND*A+1))+C(A)
07810   PRINT"*NO SURVIVERS ARE REPORTED IN SECTION"A
07820   PRINT"*THE BEES WILL NOT ENTER A SECITON WITH"
07830   PRINT"NO HUMAN INHABITANTS, SO SECTION"A
07840   PRINT"IS COMPLTELY LACKING LIFE OF ANY KIND"
07850   K(A)=2
07860   R(A)=-1
07870   GOTO 3480
07880   REM    *** CASUALTY REPORT ***
07890   PRINT"  6)          CASUALTY REPORT"
07900   PRINT"SECTION";
07910   INPUT A
07920   PRINT"*****************************************"
```

```
07930   IF A<20 THEN 7960
07940   LET D=-1
07950   FOR A=1 TO 21
07960   IF C(A)=0 THEN 8060
07970   IF C(A)>=1000000 THEN 8020
07980   PRINT"SECTION"A":     "C(A)"CASUALTIES REPORTED"
07990   GOTO 8030
08000   PRINT"SECTION"A":     NO REE RELATED CASUALTIES"
08010   GOTO 8030
08020   PRINT"SECTION"A":       "C(A)/1000000"MILLION CASUALTIES"
08030   PRINT"****************************************"
08040   F=C(A)+F
08050   IF D<>-1 THEN 8120
08060   NEXT A
08070   D=0
08080   IF F<1000000 THEN 8110
08090   PRINT"TOTAL CASUALTIES REPORTED: "F/1000000"MILLION"
08100   GOTO 8140
08110   PRINT"TOTAL CASUALTIES REPORTED:"F
08120   IF W=0 THEN 8430
08130   F=0
08140   GOTO 3480
08150   REM     *** PRINT COMMANDS IN SHORT ***
08160   PRINT"************************ COMMANDS **************************"
08170   PRINT
08180   PRINT"          1) ATTACK SCAN MAP"
08190   PRINT"          2) ETA REPORT"
08200   PRINT"          3) BATTLE PHASE OPTIONS"
08210   PRINT"                  1. BEE COCKTAIL"
08220   PRINT"                  2. PROJECT QUEEN"
08230   PRINT"                  3. PROJECT SWARM TIME"
08240   PRINT"                  4. PROJECT STERILE MALE"
08250   PRINT"                  5. DESTRUCTION"
08260   PRINT"                  6. URBAN DEFENSES"
08270   PRINT"                          A) FLIGHT PATTERNS"
08280   PRINT"                          B) SONIC BOOM"
08290   PRINT"                          C) SUPER-SONIC BEAMS"
08300   PRINT"                          D) POLLUTION"
08310   PRINT"                          E) METHYL PARATHION"
08320   PRINT"                          F) FIRE WALL"
08330   PRINT"                          G) STROBE LIGHT"
08340   PRINT"          4) EVACUATION PROCEDURES"
08350   PRINT"          5) NUCLEAR DESTRUCTION"
08360   PRINT"          6) CASUALTY REPORT"
08370   PRINT"          7) COMMANDS (SHORT)"
08380   PRINT"          8) CANCEL GAME"
08390   PRINT
08400   GOTO 3480
08410   REM     *** CANCEL GAME ***
08420   PRINT"GAME CANCELLED"
08430   PRINT"DO YOU WANT TO PLAY AGAIN";
08440   INPUT X$
08450   IF X$="NO" THEN 8630
08460   PRINT"ANOTHER GAME IS NOW BEING SET UP...."
08470   MAT E=ZER
08480   MAT S=ZER
08490   MAT U=ZER
08500   MAT G=ZER
08510   MAT M=ZER
08520   MAT D=ZER
08530   MAT C=ZER
08540   MAT V=ZER
08550   MAT R=ZER
08560   MAT H=ZER
08570   A=RND(-TIM(0))*0
08580   PRINT" **********READY!"
08590   PRINT
08600   PRINT
08610   PRINT
08620   GOTO 3370
08630   PRINT
08640   PRINT
08650   PRINT
08660   PRINT"     THIS GAME WAS BASED ON THE BOOK THE SWARM, BY AUTHUR HERZOG."
08670   PRINT"IT WAS CREATED AND PRODUCED BY MARK K. MILLER.  IT WAS ORIGINAL-"
08680   PRINT"LY RELEASED IN ALBUQUERQUE, N.M. ON APRIL 1,1976.     THANK YOU."
08690   END
```



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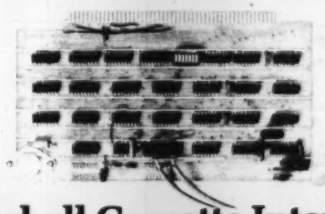

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EUCHRE

by Victor Raybaud
113 Larzelere
Central Michigan University
Mt. Pleasant, MI 48858

Language: BASIC (Univac 1106)

Description: This game pits the user against the computer in a card game called Euchre. See the program for instructions. (Note: if you haven't played or even heard of Euchre before, they may be a little hard to understand.)

EUCHRE uses several functions which may not be familiar to you. They are:

INP- Takes the INteger Part of a number. Same as INT in most BASICs.

MOD- MOD(X,Y) returns the value of X Mod Y. For example, 154 Mod 100 is 54, 299 Mod 100 is 99, 12 Mod 100 is 12, and -20 Mod 100 is 80.

CAT!- Concatenates two strings ("adds" them).

Notice also that Univac 1106 Basic permits any statement to follow an IF...THEN. Have "fun" converting this to your BASIC if it doesn't have this feature! Also remember that the strings are string vectors, so Z$(I) refers to a whole group of characters (and not the Ith character in a string, as in HP BASIC).

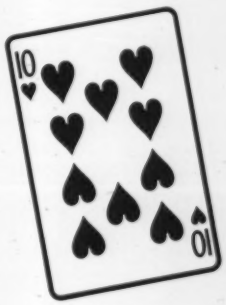
EUCHRE1 (to the left) contains instructions for playing the game.

EUCHRE2 (below and following two pages) is the game itself. The third page over contains part of a sample run.

```
CTURE*EUCHRE1
00100 REM THIS PROGRAM WRITTEN BY
00200 REM VICTOR J. RAYBAUD
00300 REM CMU SENIOR
00400 REM CPS MAJOR 2-76
00500 REM TITLE : INSTRUCTIONS TO EUCHRE FOR TWO
00600 PRINT
00700 PRINT
00800 PRINT
00900 PRINT 'THIS IS THE GAME OF TWO-HANDED EUCHRE.'
01000 PRINT 'DO YOU NEED INSTRUCTIONS? ';
01100 INPUT A$
01200 IF A$='YES' OR A$='Y' THEN 1700
01300 IF A$='NO' OR A$='N' THEN 9400
01400 PRINT 'PLEASE INPUT YES OR NO.'
01500 PRINT
01600 GOTO 1000
01700 PRINT
01800 PRINT
01900 PRINT 'THIS IS THE GAME OF TWO-HANDED EUCHRE. THE OBJECT OF'
02000 PRINT 'THE GAME IS TO GET 10 POINTS. AFTER EACH HAND ONE OF'
02100 PRINT 'US WILL GET 1,2,3, OR 4 POINTS, DEPENDING ON THE OUT-'
02200 PRINT 'COME OF EACH HAND.'
02300 PRINT
02400 PRINT 'THE DECK CONSISTS OF 24 CARDS. THE RANK FROM LOW TO'
02500 PRINT 'HIGH IS 9,10,J,Q,K,A. IF THAT SUIT IS TRUMP (EITHER'
02600 PRINT 'CLUBS, DIAMONDS, HEARTS, OR SPADES) THEN THE ORDER IS'
02700 PRINT '9,10,Q,K,A,J,J. THE FIRST J IS THE LEFT BOWER (JACK '
02800 PRINT 'OF SAME COLOR BUT DIFFERENT SUIT) AND THE SECOND J IS'
02900 PRINT 'THE RIGHT BOWER (JACK OF THE SUIT CALLED TRUMP).'
03000 PRINT
03100 PRINT 'PLAY OF GAME PROCEEDS AS FOLLOWS:'
03200 PRINT
03300 PRINT '1) EACH PERSON IS DEALT 12 CARDS IN THE FOLLOWING'
03400 PRINT '    MANNER. FOUR CARDS FACE DOWN, FOUR CARDS FACE UP'
03500 PRINT '    (ONE ON TOP OF EACH OF THE FACE DOWN CARDS) AND'
03600 PRINT '    FOUR CARDS IN YOUR HAND. LAYOUT OF THE CARDS ARE'
03700 PRINT '    IN THE FOLLOWING FORMAT:'
03800 PRINT
03900 PRINT TAB(10);'U  U  U  U'
04000 PRINT
04100 PRINT TAB(10);'*  *  *  *'
04200 PRINT TAB(10);'C  C  C  C'
04300 PRINT TAB(7);'----------------'
04400 PRINT TAB(10);'C  C  C  C'
04500 PRINT TAB(10);'*  *  *  *'
04600 PRINT
04700 PRINT TAB(10);'Y  Y  Y  Y'
04800 PRINT 'WHERE'
04900 PRINT '     * - CARDS FACE DOWN'
05000 PRINT '     C - CARDS FACE UP'
05100 PRINT '     Y - CARDS IN YOUR HAND (UNSEEN BY ME)'
05200 PRINT '     U - CARDS IN MY HAND (UNSEEN BY YOU)'
05300 PRINT
05400 PRINT 'CARDS ABOVE DOTTED LINE ARE MINE, BELOW DOTTED LINE'
05500 PRINT 'ARE YOURS. FACE DOWN CARDS ARE REVEALED ONCE THE ONE'
05600 PRINT 'ON TOP OF IT HAS BEEN PLAYED.'
05700 PRINT
05800 PRINT '2) THE PERSON WHO DIDN''T DEAL HAS THE CHOICE OF'
05900 PRINT '    CALLING A SUIT TRUMP OR PASSING. IF HE PASSES'
06000 PRINT '    THEN THE DEALER GETS STUCK WITH CALLING TRUMP.'
06100 PRINT '    INPUT C - CLUBS, D - DIAMONDS, H - HEARTS, S -'
06200 PRINT '    SPADES, P - PASS.'
06300 PRINT
06400 PRINT '3) THE PERSON WHO DIDN''T DEAL LEADS WITH FIRST PLAY.'
06500 PRINT '    FOLLOW PLAY WITH SAME SUIT. IF YOU DON''T HAVE'
06600 PRINT '    THAT SUIT THEN PLAY ANYTHING, TRUMP TAKES ALL,'
06700 PRINT '    EXCEPT HIGHER TRUMP.'
06800 PRINT
06900 PRINT '4) THE WINNER OF PLAY LEADS NEXT PLAY. CONTINUE PLAY'
07000 PRINT '    OF HAND UNTIL ALL CARDS ARE EXHAUSTED.'
07100 PRINT
07200 PRINT '5) INPUT CARD TO BE PLAYED BY THE FOLLOWING FORMAT:'
07300 PRINT '      CARD RANK , SUIT'
07400 PRINT '    RANK - 9,10,J,Q,K,A'
07500 PRINT '    SUIT - C,D,H,S'
07600 PRINT '    EXAMPLE:   Q,S       QUEEN OF SPADES'
07700 PRINT
07800 PRINT '6) WHOEVER CALLS TRUMP HAS AN OBLIGATION TO WIN AT'
07900 PRINT '    LEAST SEVEN TRICKS. IF NOT THEN HE IS EUCHRED.'
08000 PRINT
08100 PRINT '7) POINTS ARE ASSIGNED AS FOLLOWS:'
08200 PRINT '    IF YOU CALL TRUMP YOU GET'
08300 PRINT '      1 POINT  - IF YOU WIN AT LEAST 7 TRICKS'
08400 PRINT '      2 POINTS - IF YOU WIN 9 OR 10 TRICKS'
08500 PRINT '      3 POINTS - IF YOU WIN 11 TRICKS'
08600 PRINT '      4 POINTS - IF YOU WIN ALL 12 TRICKS'
08700 PRINT '    IF YOU DIDN''T CALL TRUMP YOU GET'
08800 PRINT '      2 POINTS - IF YOU WIN AT LEAST 6 TRICKS (EUCHRE)'
08900 PRINT '      4 POINTS - IF YOU WIN ALL 12 TRICKS'
09000 PRINT
09100 PRINT '8) DEALS ALTERNATE AT THE END OF EACH HAND.'
09200 PRINT
09300 PRINT '9) MOST IMPORTANT - NO CHEATING !!!!!!!'
09400 PRINT
09500 PRINT
09600 CHAIN EUCHRE2
09700 END
```

```
    EUCHRE2
00100 REM THIS PROGRAM WRITTEN BY
00200 REM VICTOR J. RAYBAUD
00300 REM CMU-SENIOR
00400 REM CPS MAJOR 2-76
00500 REM TITLE : EUCHRE FOR TWO
00600 DIM B(24),Z$(24),D(4),G(24),N(12),P$(12)
00700 DIM K$(12),L$(12),Q(24),R$(24),S(12),U$(12)
00800 DIM V(4),W(4),E(8),F(8)
00900 RANDOMIZE
01000 FOR I=1 TO 24
01100 READ B(I),Z$(I)
01200 NEXT I
01300 MAT G=ZER(24)
01400 LET P3=P4=T1=T2=0
01500 PRINT
01600 PRINT 'WOULD YOU LIKE TO DEAL FIRST? ';
01700 INPUT A$
01800 IF A$='YES' OR A$='Y' THEN 2200
01900 IF A$='NO' OR A$='N' THEN 2500
02000 PRINT 'PLEASE INPUT YES OR NO.'
02100 GOTO 1500
02200 LET W1=1
02300 LET W2=2
02400 GOTO 2700
02500 LET W1=2
02600 LET W2=1
02700 FOR I=1 TO 24
```

```
02800 LET X1=INP(100*(RND(E2)))
02900 LET Y=MOD(X1,24)+1
03000 IF I=1 THEN 3800
03100 FOR J=1 TO I-1
03200 IF G(J)=Y THEN 3500
03300 NEXT J
03400 GOTO 3800
03500 LET Y=Y+7
03600 IF Y>24 THEN Y=Y-24
03700 GOTO 3100
03800 LET R$(I)=Z$(Y)
03900 LET Q(I)=B(Y)
04000 LET G(I)=Y
04100 NEXT I
04200 LET J=1
04300 FOR I=1 TO 23 STEP 2
04400 LET P$(J)=R$(I)
04500 LET N(J)=Q(I)
04600 LET U$(J)=R$(I+1)
04700 LET S(J)=Q(I+1)
04800 LET J=J+1
04900 NEXT I
05000 FOR I=1 TO 4
05100 LET K$(I)=P$(I)
05200 LET K$(I+4)=P$(I+4)
05300 LET L$(I)=U$(I)
05400 LET L$(I+4)=' U '
05500 NEXT I
05600 FOR I=9 TO 12
05700 LET K$(I)=L$(I)='***'
05800 NEXT I
05900 PRINT
06000 PRINT
06100 IF W1=1 THEN 6400
06200 PRINT 'I DEALT THE FOLLOWING CARDS:'
06300 GOTO 6500
06400 PRINT 'YOU DEALT THE FOLLOWING CARDS:'
06500 GOSUB 47900
06600 IF W1=1 THEN 9200
06700 PRINT
06800 PRINT 'WHAT''S TRUMP? ';
06900 INPUT T$
07000 IF T$='C' THEN 7700
07100 IF T$='D' THEN 7900
07200 IF T$='S' THEN 8100
07300 IF T$='H' THEN 8300
07400 IF T$='P' THEN 8500
07500 PRINT 'PLEASE INPUT C,D,S,H, OR P.'
07600 GOTO 6700
07700 PRINT 'CLUBS ARE TRUMP'
07800 GOTO 9000
07900 PRINT 'DIAMONDS ARE TRUMP'
08000 GOTO 9000
08100 PRINT 'SPADES ARE TRUMP'
08200 GOTO 9000
08300 PRINT 'HEARTS ARE TRUMP'
08400 GOTO 9000
08500 IF W1=1 THEN 8800
08600 PRINT 'YOU PASSED, SO I SAY ';
08700 GOTO 9400
08800 PRINT 'SORRY, YOU GET STUCK CALLING TRUMP!!!'
08900 GOTO 6700
09000 LET W3=1
09100 GOTO 17100
09200 PRINT
09300 PRINT 'YOU DEALT SO I SAY ';
09400 MAT V=ZER(4)
09500 FOR I=1 TO 4
09600 FOR J=1 TO 12
09700 LET I1=INP(N(J)/100)
09800 IF I1=I THEN V(I)=V(I)+N(J)
09900 NEXT J
10000 NEXT I
10100 FOR I=1 TO 12
10200 LET A1=MOD(N(I),100)
10300 LET I1=INP(N(I)/100)
10400 IF A1=11 THEN 10600
10500 GOTO 11800
10600 ON I1 GOTO 10700,11000,11300,11600
10700 LET V(1)=V(1)+5
10800 LET V(2)=V(2)+215
10900 GOTO 11800
11000 LET V(2)=V(2)+5
11100 LET V(1)=V(1)+115
11200 GOTO 11800
11300 LET V(3)=V(3)+5
11400 LET V(4)=V(4)+415
11500 GOTO 11800
11600 LET V(4)=V(4)+5
11700 LET V(3)=V(3)+315
11800 NEXT I
11900 MAT W=ZER(4)
12000 FOR I=1 TO 4
12100 FOR J=1 TO 12
12200 LET I2=INP(S(J)/100)
12300 IF I2=I THEN W(I)=W(I)+S(J)
12400 NEXT J
12500 NEXT I
12600 FOR J=1 TO 12
12700 LET A2=MOD(S(J),100)
12800 LET I2=INP(S(J)/100)
12900 IF A2=11 THEN 13100
13000 GOTO 14300
13100 ON I2 GOTO 13200,13500,13800,14100
13200 LET W(1)=W(1)+5
13300 LET W(2)=W(2)+215
13400 GOTO 14300
13500 LET W(2)=W(2)+5
13600 LET W(1)=W(1)+115
13700 GOTO 14300
13800 LET W(3)=W(3)+5
13900 LET W(4)=W(4)+415
14000 GOTO 14300
14100 LET W(4)=W(4)+5
14200 LET W(3)=W(3)+315
14300 NEXT J
14400 FOR I=1 TO 4
14500 LET D(I)=W(I)-V(I)
14600 NEXT I
14700 LET I=1
14800 FOR J=2 TO 4
14900 IF D(I)>D(J) THEN 15100
15000 LET I=J
15100 NEXT J
15200 IF D(I)<300 THEN 16800
15300 ON I GOTO 15400,15700,16000,16300,16600
15400 PRINT 'CLUBS ARE TRUMP'
15500 LET T$='C'
15600 GOTO 17000
15700 PRINT 'SPADES ARE TRUMP'
15800 LET T$='S'
15900 GOTO 17000
16000 PRINT 'DIAMONDS ARE TRUMP'
16100 LET T$='D'
16200 GOTO 17000
16300 PRINT 'HEARTS ARE TRUMP'
16400 LET T$='H'
16500 GOTO 17000
16600 PRINT 'PASS'
16700 GOTO 9700
16800 IF W1=1 THEN I=5 ELSE PRINT 'THANKS A LOT!!!'
16900 GOTO 15300
17000 LET W3=2
17100 IF T$='C' THEN 17700
17200 IF T$='D' THEN 18000
17300 IF T$='H' THEN 18300
17400 LET B1=1
17500 LET B2=2
17600 GOTO 18500
17700 LET B1=2
17800 LET B2=1
17900 GOTO 18500
18000 LET B1=4
18100 LET B2=3
18200 GOTO 18500
18300 LET B1=3
18400 LET B2=4
18500 LET C=B1*100+11
18600 FOR I=1 TO 12
18700 IF N(I)=C THEN N(I)=B2*100+15
18800 IF S(I)=C THEN S(I)=B2*100+15
18900 NEXT I
19000 LET C=B2*100+11
19100 FOR I=1 TO 12
19200 IF N(I)=C THEN N(I)=B2*100+16
19300 IF S(I)=C THEN S(I)=B2*100+16
19400 NEXT I
19500 IF W2=2 THEN 24900
19600 PRINT
19700 PRINT 'PLAY A CARD ';
19800 INPUT R3$,S3$
19900 GOSUB 51400
20000 LET C3$=CAT$(R3$,S3$)
20100 FOR I=1 TO 12
20200 LET B3$=TRM$(P$(I))
20300 IF B3$=C3$ THEN 20500
20400 NEXT I
20500 LET V3=N(I)
20600 LET S5=INP(V3/100)
20700 LET A1=MOD(V3,100)
20800 LET J=1
20900 FOR I=1 TO 8
21000 LET F1=INP(S(I)/100)
21100 IF F1<>S5 THEN 21400
21200 LET E(J)=S(I)
21300 LET J=J+1
21400 NEXT I
21500 IF J=1 THEN 22500
21600 IF J=2 THEN V4=E(J-1) ELSE 21800
21700 GOTO 31000
21800 FOR I=1 TO J-1
21900 LET M=MOD(E(I),100)-A1
22000 IF M<0 THEN 22300
22100 LET V4=E(I)
22200 GOTO 31000
22300 NEXT I
22400 GOTO 24100
22500 FOR I=1 TO 8
22600 LET F1=INP(S(I)/100)
22700 IF F1<>B2 THEN 23000
22800 LET E(J)=S(I)
22900 LET J=J+1
23000 NEXT I
23100 IF J<>1 THEN 24000
23200 FOR I=1 TO 8
23300 LET F2=MOD(S(I),100)
23400 IF F2=J+8 THEN 23800
23500 NEXT I
23600 LET J=J+1
23700 GOTO 23200
23800 LET V4=S(I)
23900 GOTO 31000
24000 IF J=2 THEN 24700
24100 LET M=1
24200 FOR I=2 TO J-1
24300 IF E(M)>E(I) THEN M=I
24400 NEXT I
24500 LET V4=E(M)
24600 GOTO 31000
24700 LET V4=E(J-1)
24800 GOTO 31000
24900 LET H=0
25000 FOR J=1 TO 4
25100 IF J=B2 THEN 29700
25200 LET M=1
25300 FOR I=1TO 8
25400 LET S5=INP(N(I)/100)
25500 IF J<>S5 THEN 25800
25600 LET F(M)=N(I)
25700 LET M=M+1
25800 NEXT I
25900 IF M=1 THEN 27600
26000 IF M<>2 THEN 26300
26100 LET V3=F(1)
26200 GOTO 26800
26300 LET Z1=1
26400 FOR I=2 TO M-1
26500 IF F(Z1)<F(I) THEN Z1=I
26600 NEXT I
26700 LET V3=F(Z1)
26800 FOR I=1 TO 8
26900 LET S6=INP(S(I)/100)
27000 IF S6<>J THEN 27200
27100 IF S(I)>V3 THEN 27400
27200 NEXT I
27300 GOTO 29700
27400 LET V4=S(I)
27500 GOTO 31000
27600 FOR I=1 TO 8
27700 LET S5=INP(N(I)/100)
27800 IF S5=B2 THEN 29700
27900 NEXT I
28000 LET M=1
28100 FOR I=1 TO 8
28200 LET S6=INP(S(I)/100)
28300 IF S6<>J THEN 28600
28400 LET E(M)=S(I)
28500 LET M=M+1
28600 NEXT I
28700 IF M=1 THEN 29700
28800 IF M<>2 THEN 29100
28900 LET V4=E(1)
29000 GOTO 31000
29100 LET J=1
29200 FOR I=1 TO M-1
29300 IF E(J)>E(I) THEN J=I
29400 NEXT I
29500 LET V4=E(J)
29600 GOTO 31000
29700 IF H=1 THEN 30200
29800 NEXT J
29900 LET H=1
30000 LET J=B2
30100 GOTO 25200
30200 LET H=9
```



```
30300 FOR I=1 TO 8
30400 LET A2=MOD(S(I),100)
30500 IF A2=H THEN 30900
30600 NEXT I
30700 LET H=H+1
30800 GOTO 30300
30900 LET V4=S(I)
31000 LET S6=INP(V4/100)
31100 LET A2=MOD(V4,100)-8
31200 ON S6 GOTO,31300,31600,31900,32200
31300 LET S4$='C'
31400 IF A2=7 THEN S4$='S'
31500 GOTO 32400
31600 LET S4$='S'
31700 IF A2=7 THEN S4$='C'
31800 GOTO 32400
31900 LET S4$='D'
32000 IF A2=7 THEN S4$='H'
32100 GOTO 32400
32200 LET S4$='H'
32300 IF A2=7 THEN S4$='D'
32400 ON A2 GOTO 32500,32700,32900,33100,33300,
32500 LET R4$='9'
32600 GOTO 33600                    33500,32900,32900
32700 LET R4$='10'
32800 GOTO 33600
32900 LET R4$='J'
33000 GOTO 33600
33100 LET R4$='Q'
33200 GOTO 33600
33300 LET R4$='K'
33400 GOTO 33600
33500 LET R4$='A'
33600 LET C4$=CAT$(R4$,S4$)
33700 IF W2=1 THEN 34400
33800 PRINT
33900 PRINT 'I PLAY ';C4$
34000 PRINT 'PLAY A CARD';
34100 INPUT R3$,S3$
34200 GOSUB 51400
34300 GOTO 34500
34400 PRINT 'I PLAY ';C4$
34500 LET C3$=CAT$(R3$,S3$)
34600 FOR I=1 TO 12
34700 LET B3$=TRM$(P$(I))
34800 IF B3$=C3$ THEN 35000
34900 NEXT I
35000 LET V3=N(I)
35100 LET S5=INP(V3/100)
35200 LET S6=INP(V4/100)
35300 IF W2=1 THEN 36500
35400 IF S5=S6 THEN 36000
35500 IF S5=B2 THEN 36100
35600 LET P4=P4+1
35700 LET W2=2
35800 PRINT 'MY TRICK'
35900 GOTO 36800
36000 IF V3<V4 THEN 35600
36100 LET P3=P3+1
36200 LET W2=1
36300 PRINT 'YOUR TRICK'
36400 GOTO 36800
36500 IF S5=S6 THEN 36000
36600 IF S6=B2 THEN 35600
36700 GOTO 36100
36800 FOR I=5 TO 8
36900 LET B3$=TRM$(P$(I))
37000 IF B3$=C3$ THEN 37300
37100 NEXT I
37200 GOTO 37600
37300 LET K$(I)=P$(I)=''
37400 LET N(I)=0
37500 GOTO 38700
37600 FOR I=1 TO 4
37700 LET B3$=TRM$(P$(I))
37800 IF B3$=C3$ THEN 38100
37900 NEXT I
38000 GOTO 38700
38100 LET K$(I)=P$(I+8)
38200 LET K$(I+8)='  '
38300 LET P$(I)=P$(I+8)
38400 LET P$(I+8)='  '
38500 LET N(I)=N(I+8)
38600 LET N(I+8)=0
38700 LET C4$=CAT$(R4$,S4$)
38800 FOR I=5 TO 8
38900 LET B3$=TRM$(U$(I))
39000 IF B3$=C4$ THEN 39300
39100 NEXT I
39200 GOTO 39600
39300 LET L$(I)=U$(I)=''
39400 LET S(I)=0
39500 GOTO 40700
39600 FOR I=1 TO 4
39700 LET B3$=TRM$(U$(I))
39800 IF B3$=C4$ THEN 40100
39900 NEXT I
40000 GOTO 40700
40100 LET L$(I)=U$(I+8)
40200 LET L$(I+8)='  '
40300 LET U$(I)=U$(I+8)
40400 LET U$(I+8)='  '
40500 LET S(I)=S(I+8)
40600 LET S(I+8)=0
40700 LET S7=P3+P4
40800 IF S7=12 THEN 41200
40900 PRINT 'TRICKS: ME';P4;'YOU';P3
41000 GOSUB 47900
41100 GOTO 19500
41200 PRINT 'TRICKS AT END OF HAND: ME';P4;'YOU';P3
41300 IF W3=1 THEN 43800
41400 IF P4=0 THEN 42000
41500 IF P4<7 THEN 42300
41600 IF P4=7 OR P4=8 THEN 42600
41700 IF P4=9 OR P4=10 THEN 42900
41800 IF P4=11 THEN 43200
41900 IF P4=12 THEN 43500
42000 PRINT 'WHAT LUCK, YOU GET 4 POINTS'
42100 LET T1=T1+4
42200 GOTO 45300
42300 PRINT 'EUCHRE, YOU GET 2 POINTS'
42400 LET T1=T1+2
42500 GOTO 45300
42600 PRINT 'I GOT MY 7 TRICKS'
42700 LET T2=T2+1
42800 GOTO 45300
42900 PRINT 'I GOT';P4;'TRICKS, I GET 2 POINTS'
43000 LET T2=T2+2
43100 GOTO 45300
43200 PRINT 'I GOT 11 TRICKS, I GET 3 POINTS'
43300 LET T2=T2+3
43400 GOTO 45300
43500 PRINT 'WHAT SKILL, I GET 4 POINTS'
43600 LET T2=T2+4
43700 GOTO 45300
43800 IF P3=0 THEN 43500
43900 IF P3<7 THEN 44400
```

```
44000 IF P3=7 OR P3=8 THEN 44600
44100 IF P3=9 OR P3=10 THEN 44900
44200 IF P3=11 THEN 45100
44300 IF P3=12 THEN 42000
44400 PRINT 'EUCHRE, I GET 2 POINTS'
44500 GOTO 43000
44600 PRINT 'YOU GOT YOUR 7 TRICKS'
44700 LET T1=T1+1
44800 GOTO 45300
44900 PRINT 'YOU GOT';P3;'TRICKS, YOU GET 2 POINTS'
45000 GOTO 42400
45100 PRINT 'YOU GOT 11 TRICKS, YOU GET 3 POINTS'
45200 LET T1=T1+3
45300 IF T1>=10 THEN 46900
45400 IF T2>=10 THEN 47100
45500 PRINT 'ME ';T2;' YOU ';T1
45600 IF W1=1 THEN 46200
45700 LET W1=1
45800 LET W2=2
45900 PRINT
46000 PRINT 'I DEALT LAST HAND, YOUR TURN TO DEAL'
46100 GOTO 46600
46200 LET W1=2
46300 LET W2=1
46400 PRINT
46500 PRINT 'YOU DEALT LAST HAND, MY TURN TO DEAL'
46600 MAT B=ZER(2,4)
46700 LET P3=P4=0
46800 GOTO 2700
46900 PRINT 'CONGRATULATIONS, YOU WIN';T1;'TO';T2
47000 GOTO 47200
47100 PRINT 'I WON THIS GAME';T2;'TO';T1
47200 PRINT
47300 PRINT 'WOULD YOU LIKE TO PLAY ANOTHER GAME?';
47400 INPUT A$
47500 IF A$='YES' OR A$='Y' THEN 1300
47600 IF A$='NO' OR A$='N' THEN 55900
47700 PRINT 'PLEASE INPUT YES OR NO.'
47800 GOTO 47300
47900 FOR I=5 TO 7
48000 IF L$(I)<>'  ' THEN 48700
48100 LET L$(I)=L$(I+1)
48200 LET L$(I+1)='  '
48300 LET U$(I)=U$(I+1)
48400 LET U$(I+1)='  '
48500 LET S(I)=S(I+1)
48600 LET S(I+1)=0
48700 NEXT I
48800 FOR I=5 TO 7
48900 IF K$(I)<>'  ' THEN 49600
49000 LET K$(I)=K$(I+1)
49100 LET K$(I+1)='  '
49200 LET P$(I)=P$(I+1)
49300 LET P$(I+1)='  '
49400 LET N(I)=N(I+1)
49500 LET N(I+1)=0
49600 NEXT I
49700 PRINT
49800 PRINT 'LAYOUT OF CARDS'
49900 PRINT
50000 PRINT L$(5);'   ';L$(6);'   ';L$(7);'   ';L$(8)
50100 PRINT
50200 PRINT '   ';'   ';L$(9);'   ';L$(10);'   ';L$(11);'   ';L$(12)
50300 PRINT '   ';'   ';L$(1);'   ';L$(2);'   ';L$(3);'   ';L$(4)
50400 PRINT '  ----------------------------'
50500 PRINT '   ';'   ';K$(1);'   ';K$(2);'   ';K$(3);'   ';K$(4)
50600 PRINT '   ';'   ';K$(9);'   ';K$(10);'   ';K$(11);'   ';K$(12)
50700 PRINT
50800 IF K$(5)='  ' THEN 51200
50900 PRINT 'CARDS IN YOUR HAND:'
51000 PRINT K$(5);'   ';K$(6);'   ';K$(7);'   ';K$(8)
51100 GOTO 51300
51200 PRINT 'NO CARDS IN YOUR HAND'
51300 RETURN
51400 IF R3$='9' THEN 52400
51500 IF R3$='10' THEN 52400
51600 IF R3$='J' THEN 52400
51700 IF R3$='Q' THEN 52400
51800 IF R3$='K' THEN 52400
51900 IF R3$='A' THEN 52400
52000 PRINT 'FORMAT OF INPUT IS INCORRECT'
52100 PRINT 'PLAY A CARD ';
52200 INPUT R3$,S3$
52300 GOTO 51400
52400 IF S3$='S' THEN 52900
52500 IF S3$='D' THEN 52900
52600 IF S3$='H' THEN 52900
52700 IF S3$='C' THEN 52900
52800 GOTO 52000
52900 LET C3$=CAT$(R3$,S3$)
53000 FOR I=1 TO 8
53100 LET B3$=TRM$(P$(I))
53200 IF C3$=B3$ THEN 53700
53300 NEXT I
53400 PRINT 'RULE NO. 9 ---- NO CHEATING!!!!!'
53500 PRINT 'YOU DON'T HAVE THAT CARD!'
53600 GOTO 52100
53700 IF W2=1 THEN 55200
53800 LET S6=INP(V4/100)
53900 LET S5=INP(N(I)/100)
54000 IF S5=S6 THEN 55200
54100 FOR I=1 TO 8
54200 LET S5=INP(N(I)/100)
54300 IF S5<>S6 THEN 55100
54400 PRINT 'RULE NO. 9 ----- NO CHEATING!!!!!'
54500 PRINT 'RULE NO. 3 ----- FOLLOW PLAY WITH SAME SUIT.'
54600 PRINT 'YOU CAN FOLLOW SUIT!!!'
54700 PRINT 'PLAY A CARD ';
54800 INPUT R3$,S3$
54900 GOSUB 51400
55000 GOTO 53700
55100 NEXT I
55200 RETURN
55300 DATA 109,'9C ',110,'10C',111,'JC ',112,'QC '
55400 DATA 113,'KC ',114,'AC ',209,'9S ',210,'10S'
55500 DATA 211,'JS ',212,'QS ',213,'KS ',214,'AS '
55600 DATA 309,'9D ',310,'10D',311,'JD ',312,'QD '
55700 DATA 313,'KD ',314,'AD ',409,'9H ',410,'10H'
55800 DATA 411,'JH ',412,'QH ',413,'KH ',414,'AH '
55900 PRINT
56000 PRINT 'THANKS FOR PLAYING, COME AGAIN!'
56100 END
```

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Started four years ago by a small team of games experts, games inventors and journalists who were games devotees, Games & Puzzles has since grown substantially to become recognised throughout the world as the leading authority on games, games inventions and games playing.

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```
WOULD YOU LIKE TO DEAL FIRST? ? >NO

I DEALT THE FOLLOWING CARDS:

LAYOUT OF CARDS

 U     U     U     U

      ***   ***   ***   ***
      9S    QS    KH    KC
  ----------------------------
      9C    10C   10H   JD
      ***   ***   ***   ***

CARDS IN YOUR HAND:
10S   QH    9H    JS

WHAT'S TRUMP? ? >P
YOU PASSED, SO I SAY DIAMONDS ARE TRUMP

PLAY A CARD ? >10,H
I PLAY KH
MY TRICK
TRICKS: ME 1 YOU 0

LAYOUT OF CARDS

 U     U     U     U

      ***   ***           ***
      9S    QS    JH    KC
  ----------------------------
      9C    10C   AH    JD
      ***   ***           ***

CARDS IN YOUR HAND:
10S   QH    9H    JS

I PLAY KC
PLAY A CARD? >10,C
MY TRICK
TRICKS: ME 2 YOU 0

LAYOUT OF CARDS

 U     U     U     U

      ***   ***
      9S    QS    JH    KS
  ----------------------------
      9C    KD    AH    JD
      ***                 ***

CARDS IN YOUR HAND:
10S   QH    9H    JS

I PLAY QS
PLAY A CARD? >10,S
MY TRICK
TRICKS: ME 3 YOU 0

LAYOUT OF CARDS

 U     U     U     U

      ***
      9S    10D   JH    KS
  ----------------------------
      9C    KD    AH    JD
      ***                 ***

CARDS IN YOUR HAND:
QH    9H    JS

I PLAY KS
PLAY A CARD? >A,S
RULE NO. 9 ---- NO CHEATING!!!!!
YOU DON'T HAVE THAT CARD!
PLAY A CARD ? >J,D
RULE NO. 9 ----- NO CHEATING!!!!!
RULE NO. 3 ----- FOLLOW PLAY WITH SAME SUIT.
YOU CAN FOLLOW SUIT!!!
PLAY A CARD ? >J,S
MY TRICK
TRICKS: ME 4 YOU 0

LAYOUT OF CARDS

 U     U     U     U

      ***
      9S    10D   JH
  ----------------------------
      9C    KD    AH    JD
      ***                 ***

CARDS IN YOUR HAND:
QH    9H

I PLAY 9S
PLAY A CARD? >K,D
YOUR TRICK
TRICKS: ME 4 YOU 1

LAYOUT OF CARDS

 U     U     U     U

      JC    10D   JH
  ----------------------------
      9C          AH    JD
      ***               ***

CARDS IN YOUR HAND:
QH    9H

PLAY A CARD ? >J,D
I PLAY 9D
YOUR TRICK
TRICKS: ME 4 YOU 2

LAYOUT OF CARDS

 U     U     U

      JC    10D   JH
  ----------------------------
      9C          AH    QC
      ***

CARDS IN YOUR HAND:
QH    9H

PLAY A CARD ? >Q,C
I PLAY JC
YOUR TRICK
TRICKS: ME 4 YOU 3

LAYOUT OF CARDS

 U     U     U

            10D   JH
  ----------------------------
      9C          AH
      ***

CARDS IN YOUR HAND:
QH    9H

PLAY A CARD ? >Q,H
I PLAY 10D
MY TRICK
TRICKS: ME 5 YOU 3

LAYOUT OF CARDS

 U     U     U

                  JH
  ----------------------------
      9C          AH
      ***

CARDS IN YOUR HAND:
9H

I PLAY AS
PLAY A CARD? >9,C
MY TRICK
TRICKS: ME 6 YOU 3

LAYOUT OF CARDS

 U     U

                  JH
  ----------------------------
      AC          AH

CARDS IN YOUR HAND:
9H

I PLAY QD
PLAY A CARD? >9,H
MY TRICK
TRICKS: ME 7 YOU 3

LAYOUT OF CARDS

 U

                  JH
  ----------------------------
      AC          AH

NO CARDS IN YOUR HAND

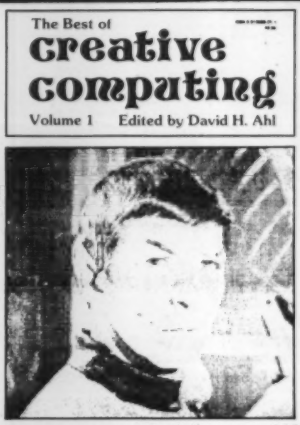
I PLAY AD
PLAY A CARD? >A,H
MY TRICK
TRICKS: ME 8 YOU 3
```

MORE COMPUTER CRITTERS!!

↑ Devilish Donald Discpack

↓ Patrick Paper Tape

The diversity in *The Best of Creative Computing — Volume 1* can only be described as staggering. The book contains 328 pages of articles and fiction about computers, games that you can play with computers and calculators, hilarious cartoons, vivid graphics and comprehensive book reviews.



Authors range from Isaac Asimov to Sen. John Tunney of California; from Marian Goldeen, an eighth-grader in Palo Alto to Erik McWilliams of the National Science Foundation; and from Dr. Sema Marks of CUNY to Peter Payack, a small press poet. In all, over 170 authors are represented in over 200 individual articles, learning activities, games, reviews and stories.

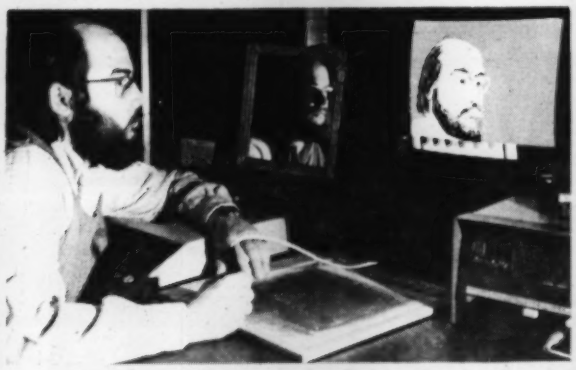
This 328-page book has 108 pages of articles on computers in education, CAI, programming, and the computer impact on society; 10 pages of fiction and poetry including a fascinating story by Isaac Asimov about all the computers on earth linking up after a nuclear war to support the few remaining survivors; 15 pages of "Foolishness" including a cute cartoon piece - called"Why We're Losing Our War Against Computers"; 26 pages on "People, Places, and Things" including the popular feature "The Compleat Computer Catalogue" which gives capsule reviews and lists sources for all kinds of computer-related goodies; 79 pages of learning activities, problems and puzzles; 29 pages continuing 18 computer games including a fantastic extended version of the single most popular computer game — Super Star Trek; and 32 pages of in-depth book and game reviews including Steve Gray's definitive review of 34 books on the Basic language.

The Best of Creative Computing - Volume 1 is available by mail for $8.95 plus 75¢ postage from Creative Computing Press, Attn: Becky P.O. Box 789-M, Morristown, N.J. 07960.

THE BEST OF BYTE — VOL. 1

The Best of Byte - Volume 1 is a 384-page blockbuster of a book which contains the majority of material from the first 12 issues of *Byte* magazine. 146 pages are devoted to "Hardware" and are cram full of how-to articles on everything from TV displays to joysticks to cassette interfaces. The section on computer kits describes building 7 major kits. But hardware without software might as well be a boat anchor, so there are 125 pages of "Software and Applications" ranging from on-line debuggers to games to a complete small business accounting system. A section on "Theory" examines the how and why behind the circuits and programs, and a final section "Opinion" looks at where this explosive new hobby is heading.

The Best of Byte - Volume 1 is edited by Carl Helmers and David Ahl and published by Creative Computing Press. Price in the US is $11.95 plus $1.00 shipping and handling ($12.95 total); foreign orders add $1.00 ($13.95 total). Orders from individuals must be prepaid. Creative Computing Press, Attn: Becky , P.O. Box 789-M, Morristown, NJ 07960. Allow 8 weeks for delivery.

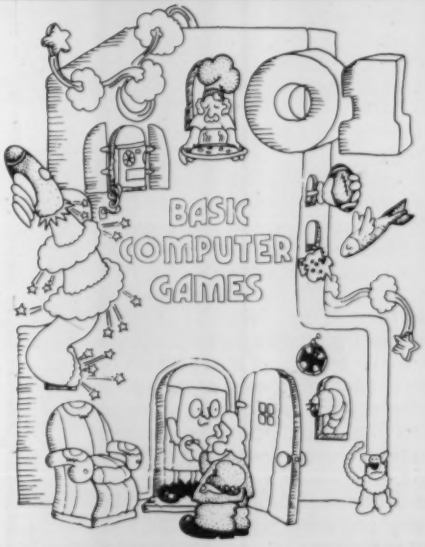


ARTIST AND COMPUTER is a unique new art book that covers a multitude of computer uses and the very latest techniques. In its pages, 35 artists who work with computers explain how the computer can be programmed either to actualize the artist's concept (such as the visualization of fabric before it is woven) or to produce finished pieces. Illustrated with more than 160 examples of computer art, 9 of them in full color, ARTIST AND COMPUTER will fascinate and inspire anyone who is interested in art or computer technology. Size 8½" x 11".

ARTIST AND COMPUTER

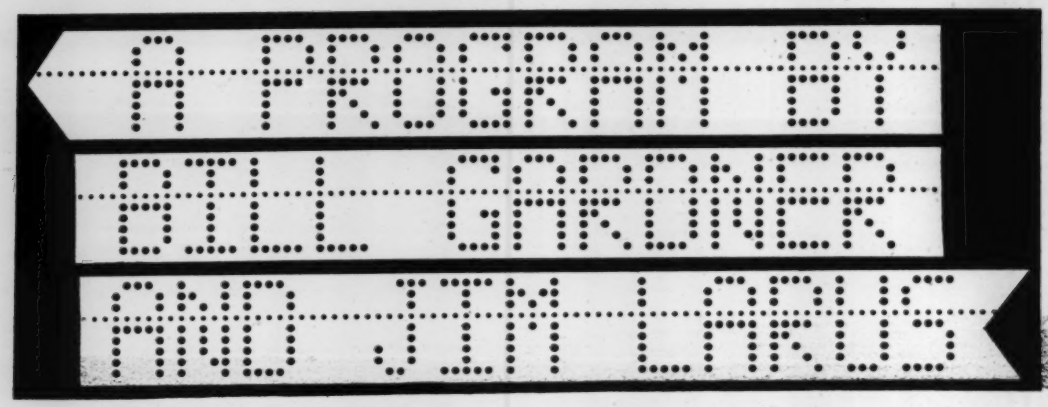
Edited by RUTH LEAVITT

Paper $4.95, cloth $10; now at selected bookstores, or send payment plus 75¢ handling to Creative Computing, P.O. Box 789-M, Morristown, N.J. 07960. N.J. residents add 5% sales tax.



101 BASIC Computer is the most popular book of computer games in the world. Every program in the book has been thoroughly tested and appears with a complete listing, sample run, and descriptive write-up. All you need add is a BASIC-speaking computer and you're set to go.

101 BASIC Computer Games. Edited by David H. Ahl. 248 pages. 8½x11 paperbound. $7.50 plus 75¢ postage and handling ($8.25 total) from Creative Computing, P.O. Box 789-M, Morristown, NJ 07960.



TICKERTAPE

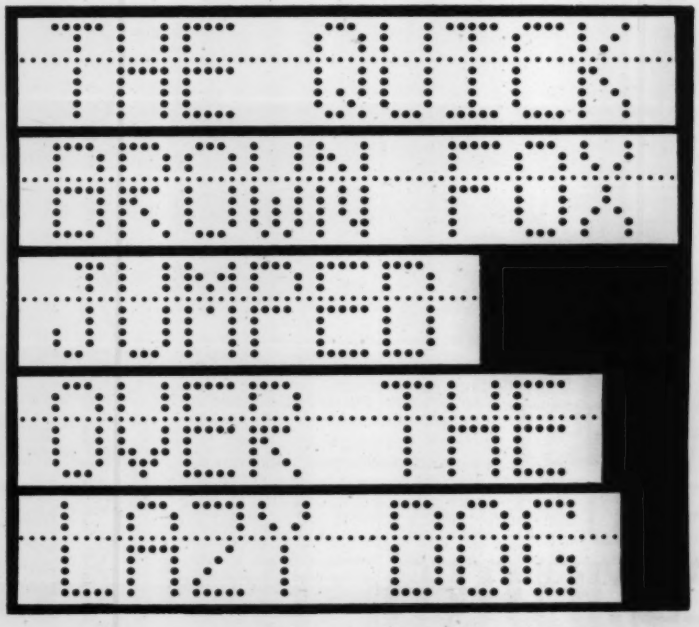
This Basic program inputs a line of characters from a Teletype, and then punches the shape of each letter on paper tape. The copy of the program that we are enclosing can handle all of the letters and numbers and the space, but there is no reason why it could not be modified to handle various symbols also.

With the exception of the input section, the operation of this program is fairly straightforward. After each character is converted to a number equivalent to its place in the alphabet (A=1, B=2, Z=26, space=27), a simple table look-up is performed to find the correct numbers to punch onto the tape. These numbers are stored in the DATA statements.

The input section, which converts the ASCII characters into a series of numbers corresponding to the location of the character in the alphabet, is the more interesting part of the program. The statement at Line 30, which assigns an ASCII character to a numerical variable, is the heart of this section. Each ASCII character produces a unique value in the variable B, all of which are powers of 2 that differ by 2 3 (8) from the previous character. The two IF-THEN statements that follow line 40, which converts the powers of 2 to a series of numbers, each take care of a special case; the space is assigned a value of 27, and the character used to pad $variables is used to indicate the end of the text.

This program will not work directly with any computer except a PDP-8, since it utilizes the internal representation of both numbers and characters of PDP-8 BASIC. Also, BASIC statements have been abbreviated in the first 3 characters, and multiple statements on one line are separated by a backslash. But it is not difficult to modify this interesting and useful program so that it could be run on almost any other computer that can handle BASIC.

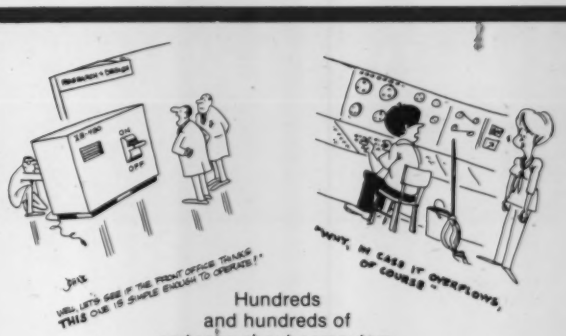
```
 10 LINA$\GOS80\L=A$(0)
 20 FORN=1TOINT((L-1)/6+1)
 25 FORM=1TO6
 30 B=MID(A$(N),M,1)
 40 C=INT(1.5+(LOG(ABS(B))/LOG(2)+113)/8)
 45 IFC=31THE75\IFC+SGN(B)>15THEC=C+12\IFC=0THEC=27
 50 FORS=0TO(C-1)*5\REAA\NEXS
 60 FORS=1TO5\REAA\PRICHR$(A)J\NEXS
 65 PRICHR$(0)J\RES
 67 NEXM
 70 NEXN
 75 GOS80\STO
 80 FORN=1TO30\PRICHR$(0)J\NEXN
 90 RET
110 DAT0,254,9,9,9,254,255,137,137,137,118,126,129,129,129,129
120 DAT255,129,129,129,126,255,137,137,137,137,255,9,9,9,1
130 DAT126,129,129,145,243,255,8,8,8,255,129,129,255,129,129
140 DAT96,128,129,127,1,255,8,20,34,193,255,128,128,128,128
150 DAT255,2,12,2,255,255,2,60,64,255,126,129,129,129,126
160 DAT255,9,9,9,6,126,129,161,65,190
170 DAT255,25,41,73,134,134,137,137,137,113,1,1,255,1,1
180 DAT127,128,128,128,127,63,96,192,96,63,127,128,112,128,127
215 DAT195,36,24,36,195,3,4,248,4,3,193,161,145,137,135
220 DAT0,0,0,0,0,126,161,137,133,126,132,130,255,128,128,194,161,145
230 DAT137,134,66,137,137,137,118,12,10,137,255,136,199,137,137,137
240 DAT248,126,137,137,137,114,1,1,249,5,3,118,137,137,137,118
250 DAT70,137,137,137,126
```



Bill Gardner and Jim Larus are students at Belmont Hill School, 350 Prospect St., Belmont, MA 02158.

This fascinating 336-page book contains the best of the articles, fiction, foolishness, puzzles, programs, games, and reviews from Volume 2 issues of *Creative Computing* magazine. The contents are enormously diverse with something for everyone. Fifteen new computer games are described with complete listings and sample runs for each; 67 pages are devoted to puzzles, problems, programs, and things to actually do. Frederik Pohl drops in for a visit along with 10 other super storytellers. And much more! The staggering diversity of the book can really only be grasped by examining the contents, or better yet, the book itself.

Price is $8.95 plus $0.75 shipping and handling in the USA ($9.70 total); outside USA, add $1.00 ($10.70 total). Individual orders must be prepaid. Creative Computing Press, Dept. CC-14, P.O. Box 789-M, Morristown, NJ 07960.



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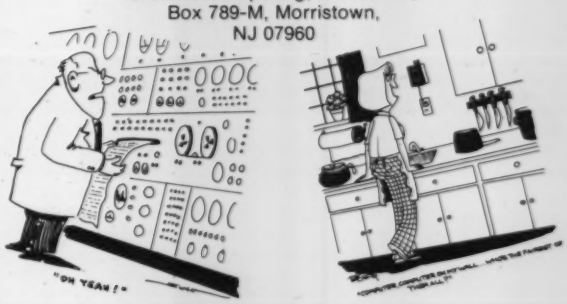

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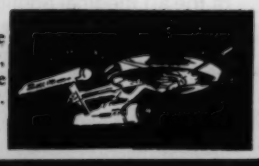

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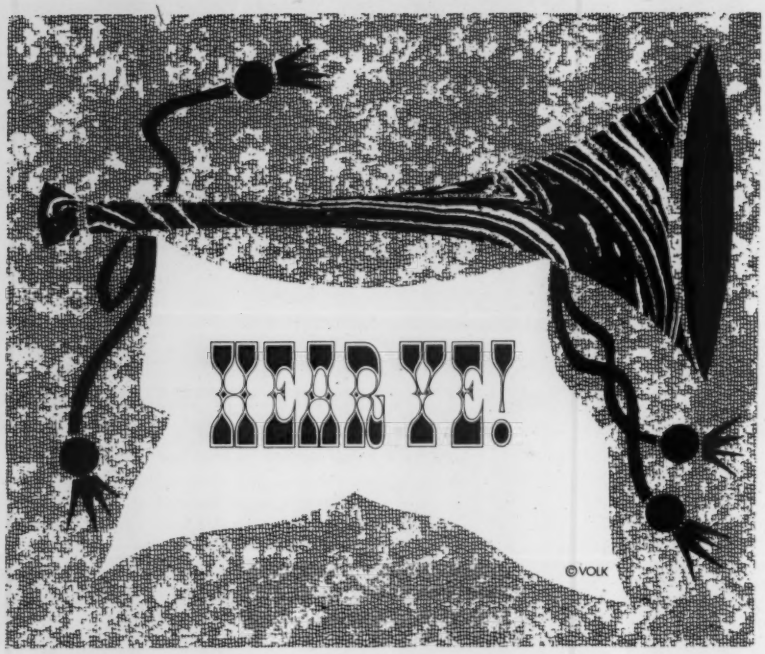

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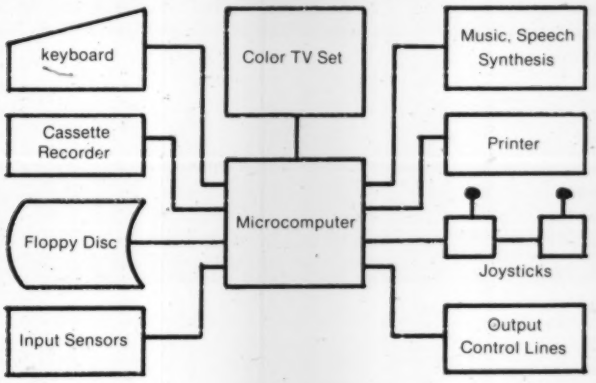
Coming in July

- **An 8-Hour Course in Basic** by Tom Dwyer and Margot Critchfield. A clear and concise, yet entertaining introduction to Basic written by the author of the best-selling "Guided Tour to Computer Programming in Basic."
- **The Scandal at the Cavandish Card Club** by Ian Malcolm Earlson. This recently discovered manuscript clearly establishes a link between Sherlock Holmes and Charles Babbage.
- **CAI: Structuring the Lesson to the Student.** Part 2 of this series by David Ahl looks at how student understanding can modify the problems presented—all in low-level Basic for your own computer.
- **A Comparison of Micros.** Five types of micro systems from single board "evaluation kits" to full system CPUs in their own box are compared and evaluated in thiis probing article by Steve Gray.
- **Games, Games, Games.** Four new ones that you'll want to get on your system post haste. Complete listings, runs, and descriptions, of course, but now optical bar code listings too!
- **A Basic for Every Season.** This in-depth comparison of all the different versions of Basic available today will include evaluations of speed, accuracy, and ease of use. We'll look at logical loops, arithmetic calculations, trig functions, table lookup, I/O, nesting, recursive calls, etc.
- **Speech Synthesis.** The ins and outs of how intelligible sounds are produced and how you can do it inexpensively on your own computer.
- **Microcomputers in Medicine.** Microprocessors put into medical instruments detect and monitor life support systems, inform surgeons instantly of body changes or heart attack prone victims of danger signals. Diagnosis of patients as well as medical histories are handled by computer. Robots are aids in hospitals. You can program your own "Shrink" on your home computer and save hundreds of dollars a week. These fascinating articles reveal state of the art medical applications with the computer.

When you get your home or office computer, will you know what to do with it?

The typical home or small business computer system starts with a microcomputer, keyboard, cassette recorder, and TV set. From there you can add the peripherals, sensors, controllers, and other devices you need for your own special applications.



Creative Computing Magazine is dedicated to describing applications for home, school, and small business computers completely and pragmatically in non-technical language. You won't need a Ph.D in Computer Science, or a technical reference library, or a computer technician beside you to get these applications up and running. We give you complete hardware and software details. Typically, applications utilize commercially available systems. However, if an application needs a piece of home-brew hardware, we tell you how to build it. Or if it requires a combination of high-level and machine language code, we give you the entire listings along with the flowcharts and algorithms.

We also run no-nonsense reviews of computers (assembled and kits), peripherals, terminals, software, and books. We're frank and honest, even if it costs us an advertiser, which it occasionally has.

Here are just some of the applications you'll see fully described in future issues of *Creative Computing*.

Building Management and Control
1. Alarm monitoring/police notification
2. Environmental control (heating, air conditioning, humidification, dehumidification, air purity, etc.)
3. Fire and smoke detection
4. Appliance control (microwave oven, gas oven, refrigerator)
5. Perimeter system control (sprinklers, outdoor lights, gates)
6. Solar and/or auxiliary energy source control
7. Watering system control based on soil moisture
8. Fuel economizing systems
9. Maintenance alert system for household devices (key component sensing and periodic preventative maintenance)

Household Management
1. Address/telephone file
2. Investment analysis
3. Loan/annuity/interest calculations and analysis
4. Checkbook maintenance
5. Periodic comparisons of expenditures vs. budget
6. Monitor time and cost of telephone calls
7. Record incoming telephone calls and select appropriate response to caller
8. Recipe file
9. Diet/nutrition analysis
10. Menu planning
11. Pantry inventory/shopping list

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3. Health maintenance instrumentation control (EKG, blood chemical analysis, diet analysis, self-diagnosis)

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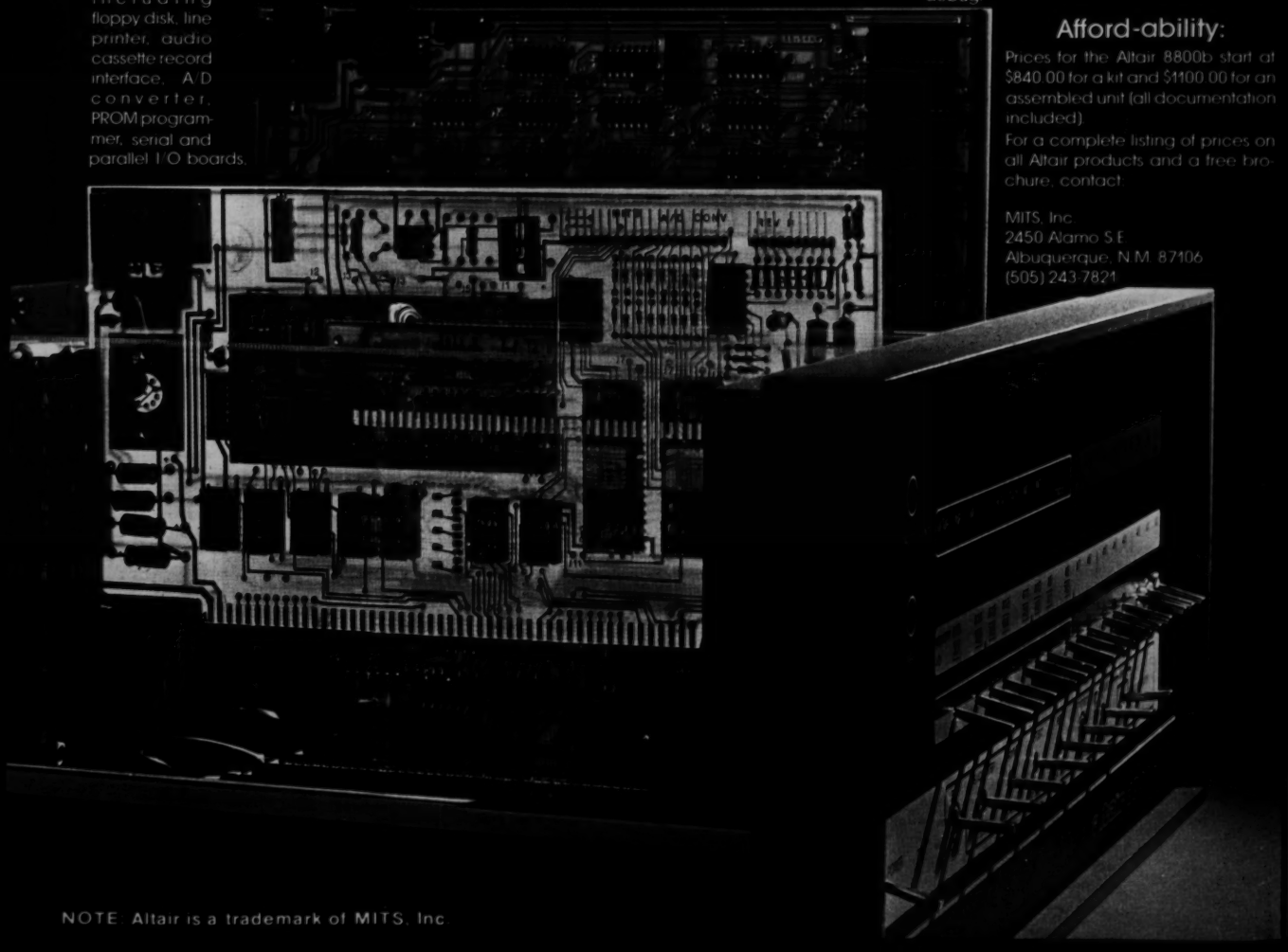

Afford-ability:

Prices for the Altair 8800b start at $840.00 for a kit and $1100.00 for an assembled unit (all documentation included).

For a complete listing of prices on all Altair products and a free brochure, contact:

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